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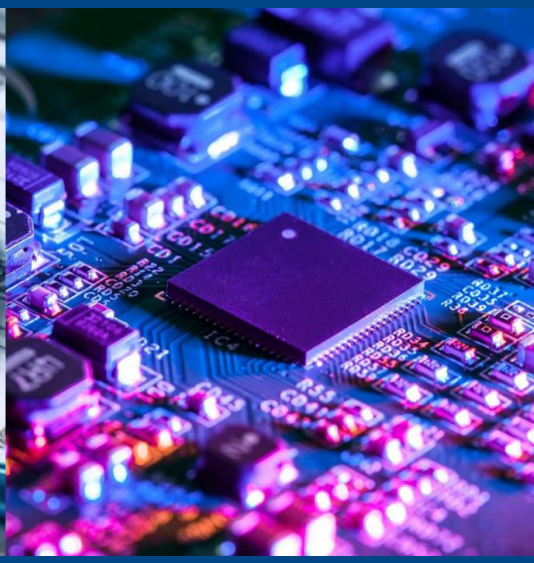

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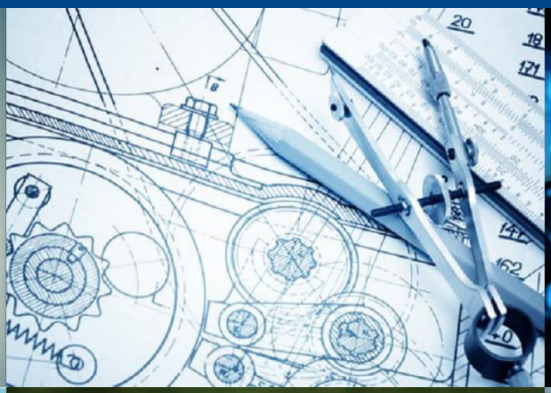

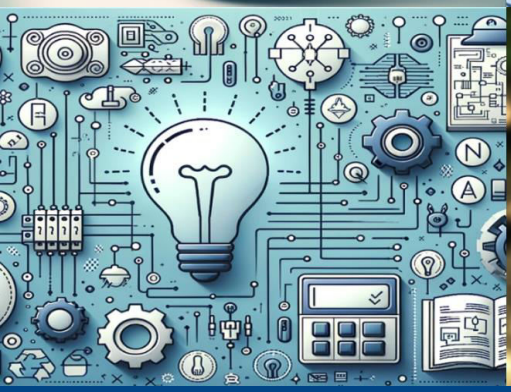

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IOT-based Animal Repellent Device using RF Technology and Mobile App Control

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ABSTRACT: IoT-based animal repellent system using RF technology to address the challenges posed by animal intrusion in restricted areas such as farms, highways, and residential zones. Unlike traditional ultrasonic devices, this solution utilizes RF frequencies, offering greater range and coverage. The system is powered by a solar panel, ensuring sustainability, and is controlled via a user-friendly mobile application. The mobile app enables users to select specific animals and adjusts the RF frequencies accordingly. The device includes an RF module and antenna for signal transmission, sensors for environmental monitoring, and a microcontroller (ESP32) to process commands and manage the system. Notifications and alerts about battery status and device performance are sent to the app using a GSM module. This innovative system provides a human, eco-friendly and efficient solution to deter animals, reducing crop damage, preventing accidents, and enhancing safety. The integration of IoT ensures real-time monitoring and remote control, making it a scalable and user friendly technology adaptable to various environments. Develop a system that utilizes AI based image recognition to detect and identify specific animal species for targeted repelling. Implement a feature to store images and data of detected animals to assist in wildlife monitoring and conservation efforts. Create a user-friendly mobile app interface to manually or automatically adjust RF frequencies based on detected animal species. Design the device to operate sustainably using solar power, ensuring continuous, eco-friendly functionality.

KEYWORDS: Animal Repellent, Radio Frequency (RF), Internet of Things (IoT), Mobile Application, Sustainability, Solar Power, Wildlife Management, Smart Device.

I. INTRODUCTION

The problem of animal intrusion in urban, rural, and highway areas poses significant challenges to both humans and wildlife. In agricultural fields, highways, or even urban settings, animals can cause significant damage to crops, vehicles, and infrastructure. Traditional methods, such as ultrasonic repellents, often lack adequate coverage and effectiveness. This project presents a **unique IoT-based animal repellent device** that utilizes **RF technology** to broadcast animal-specific frequencies, effectively repelling them over large areas. The system is controlled via a mobile app, providing users with **remote control** and monitoring features. Additionally, the device is powered by solar energy, making it both eco-friendly and sustainable. In response to the increasing demand for humane and effective strategies to manage human-wildlife interactions, this project proposes an advanced IoT-based animal repellent device that integrates Radio Frequency (RF) technology with AI-driven image recognition and a user-friendly mobile app interface. The innovative device leverages a camera equipped with artificial intelligence capabilities to automatically detect the presence of animals. Once an animal is detected, the system can either autonomously or manually adjust the RF frequencies via the mobile app to effectively repel specific animal species, minimizing human intervention and maximizing efficiency. The intelligent detection and response capabilities of this system significantly enhance the effectiveness of the repellent device [1-3]. Additionally, the system's ability to capture and store images and related information in a digital datasheet provides a valuable resource for wildlife monitoring and management. This data can be instrumental for forest departments and other conservation agencies, as it helps in tracking animal movements, behaviours, and population patterns over time. By integrating RF technology, AI, and IoT [4-6], this project aims to deliver a scalable and reliable solution that is both eco-friendly and highly effective for managing wildlife interactions. The use of advanced technologies ensures that the system not only protects human safety but also promotes wildlife conservation efforts by minimizing harm to animals. This innovative approach supports sustainable coexistence

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between humans and wildlife, addressing the needs of both communities in a balanced and ethical manner. This project aims to create an intelligent animal repellent system that combines RF technology with AI-based image recognition to effectively manage human-wildlife interactions. The device uses a camera with AI capabilities to detect and identify specific animal species and can adjust RF frequencies automatically or manually via a mobile app to repel them. In addition to improving the effectiveness of animal deterrence, the system supports wildlife monitoring by capturing and storing images and data of detected animals. This information can be a valuable asset for forest departments and conservationists, aiding in tracking animal movements and understanding wildlife behaviour. The device is also designed to be environmentally friendly, utilizing solar power for sustainable and continuous operation. By focusing on humane, non-lethal methods, this project aims to promote coexistence between humans and wildlife, enhancing safety and minimizing conflicts across different settings.

II.LITERATURE REVIEW

2.1.IoT Based Animal Detection and Alert System for Farm Fields

The main objective of this work is to alert the farmer when an animal enters into their farm field and prevent the animal entering into the form field. The animals suddenly entering to the field is the major issue that farm owners frequently deal with. The traditional farming techniques need to be replaced with smart farming methods in order to prevent the entry of animals. The proposed sytem uses the sensors, arduino and Internet of Things (IoT). This developed system also enables the farm owner to get the Short Message Service (SMS) through Global System for Mobile (GSM). In addition, it provides the access to the farm owner to control the entry of the animal to farm field automatically or manually from the home. As the developed system transmits the real time pictures of the animal to the farm owner through telegram bot, he/she will be well prepared to protect the animals. Further, the developed system makes use of speaker to play the same detected animal sound as a way to repel the animal. It also produces the fog and lights to prevent the immediate entry of animals. Thus, this work facilitates the smart way to control the wild animals entering to the farmland.

2.2.RFID Technology for Animal Tracking: A Survey

The application of animal tracking holds significant importance across diverse economic domains, encompassing sectors including livestock husbandry, agricultural practices, and the conservation of wildlife populations. It aims to track and understand animal behaviour, movement patterns, and health status. The predominant use of RFID technology is observed within the domains of logistics, localization, and the tracking of goods. Notably, the application of this technology in the field of animal tracking has experienced a significant surge in popularity in recent years. This paper conducts a systematic literature review focused on understanding how RFID technology is being applied in the field of animal tracking. We have conducted state-of-the-art research regarding animal tracking solutions in the scientific literature and patents. We have analysed these solutions targeting which animals are being tracked, which problems are addressed, operating frequency, and whether other technologies are combined with RFID for animal tracking purposes. Among the categories of problems addressed, livestock management emerged as the main area, followed by animal tracking and traceability. Mammals, especially cattle, are the most common type of animal monitored. Considering RFID technology, passive UHF tags appeared more often. Moreover, many works also employed cameras and GPS together with RFID. Finally, this work can significantly contribute to this field by systematically presenting a state-of-the-art application of RFID for animal tracking.

2.3.Anti-Adaptive Harmful Birds Repelling Method Based on Reinforcement Learning Approach

To prevent crop damage from harmful birds, various repelling methods have been studied. However, harmful birds are still causing damage in the orchard by adapting to the repelling device according to their biological characteristics. This paper proposes a method called Anti-adaptive Harmful Birds Repelling (AHBR) that uses the model-free learning idea of the Reinforcement Learning (RL) approach to repell harmful birds that can effectively prevent bird adaptation problems. To prevent adaptation, the AHBR method uses a method of learning the bird's reaction to the available threat sounds and playing them in patterns that are difficult to adapt through the RL approach. We also proposed the Long-term and Short-term (LaS) policy to meet the Markov assumptions that make RL difficult to implement in the real world. The LaS policy enable learning of the actual bird's reaction to the sound of a threat. The performance of the AHBR method was evaluated in a closed environment to experiment real harmful bird such as Brown-eared Bulbul, Great Tit, and Eurasian Magpie captured in orchards. Results obtained from the experiment showed that the AHBR

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method was on average 43.5% better than the threat sound patterns (One, Sequential, Reverse Sequential, Random) used in commercial products.

III. EXISTING PROBLEM STATEMENT

The current state of animal repellent systems predominantly utilizes ultrasonic waves as the primary technology to deter animals from entering certain areas, such as farms, highways, and residential zones. These ultrasonic devices emit sound waves at frequencies that are outside the hearing range of humans but can be perceived by animals, such as dogs, deer, or rodents. The idea behind ultrasonic repellents is to create discomfort or irritation in animals by exposing them to high-pitched sounds that disrupt their normal behaviour. The ultrasonic waves cause distress and encourage animals to leave the area in search of a more peaceful environment. However, despite their widespread use, existing ultrasonic-based systems face several challenges and limitations, which affect their effectiveness in large-scale applications. These limitations include:

3.1.Limited Coverage and Range

Ultrasonic devices have a restricted range, typically effective only over short distances (usually between 5 to 15 meters). This makes them ineffective for large properties, farms, or highways, where a wider area needs to be covered to prevent animals from entering. The limited range results in insufficient coverage, leading to situations where animals may still be able to access areas not directly within the path of the ultrasonic waves.

32.Line-of-Sight Requirement

Ultrasonic waves require a clear line of sight to be effective. Obstructions such as walls, trees, or other structures can interfere with the propagation of the sound waves. In real-world settings, especially in forests, fields, or mountainous terrains, it is often difficult to maintain a direct line of sight, thus reducing the performance of the ultrasonic system.

3.3.Ineffective for Certain Animal Species

The effectiveness of ultrasonic devices depends on the species of animals being targeted. Different animals are sensitive to different frequency ranges, and not all species react to ultrasonic waves in the same way. For example, certain animals might be less sensitive to high-frequency sound waves, while others may not perceive them at all. This lack of specificity leads to inefficiency, as one fixed frequency may not repel all animal species that might be present in the area.

3.4.Energy Consumption

Most ultrasonic systems rely on traditional power sources, often requiring electricity from mains or batteries to operate. In remote or off-grid areas, the need for an external power supply can be problematic, as it may require frequent recharging or access to electrical grids, which are not always available in rural or agricultural locations. Additionally, battery-powered devices can have limited operational time before requiring a replacement or recharge, leading to maintenance issues.

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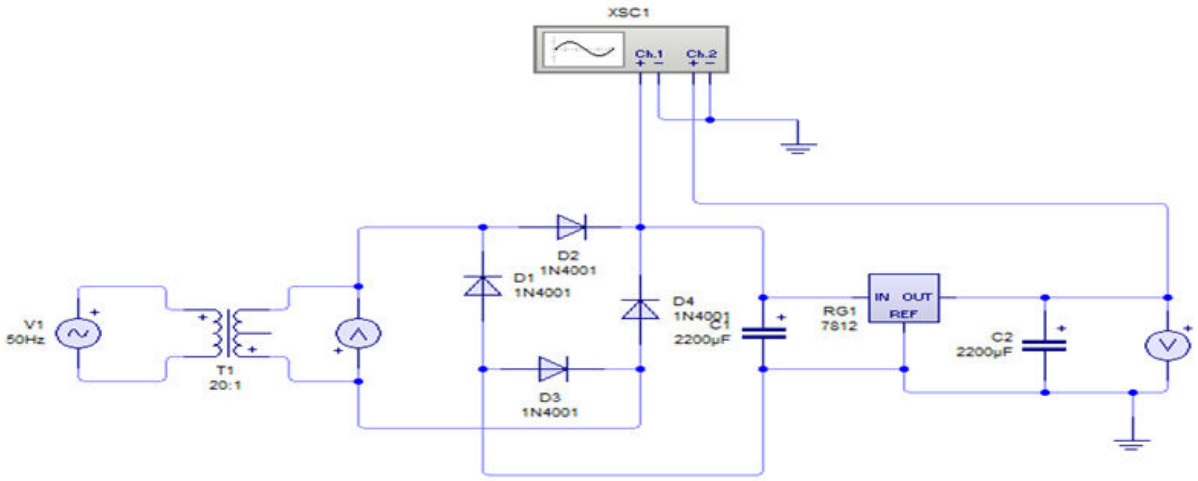

Fig 1: Construction of Ultrasonic Repeller

3.5.Non Real-Time Monitoring or Control

Many existing systems lack integration with modern technologies such as IoT (Internet of Things), which means they cannot be controlled or monitored remotely. Users must manually adjust or reset the devices, which can be inefficient and time-consuming. Without remote control, users cannot easily adjust settings, monitor battery levels, or track the effectiveness of the device over time.

3.6.Environmental Interference

Ultrasonic waves are also sensitive to environmental conditions. Factors such as temperature, humidity, and even rain can affect how well the sound waves propagate. In wet or humid conditions, the sound waves may dissipate more quickly, reducing the effective range of the system. Additionally, background noise from machinery or traffic can also interfere with the ability of ultrasonic devices to function properly, further limiting their reliability.

3.7. Lack of Customization

Ultrasonic devices generally emit sound at a fixed frequency that is designed to repel a broad range of animals. However, this lack of customization means that the frequency may not be ideal for every animal species. Moreover, users have little to no control over changing the frequency to suit specific needs. The inability to adjust frequencies based on the animal species or environmental factors limits the device's versatility and effectiveness.

3.8.Challenges in Existing System

In while ultrasonic animal repellent systems have been widely adopted due to their simplicity and low cost, their limitations include limited coverage, a reliance on line-of-sight, inefficiency for certain animal species, high power consumption, lack of remote control or real-time monitoring, and vulnerability to environmental interference. These issues make them less ideal for large-scale applications or situations where continuous and adaptable animal deterrence is required. Consequently, there is a need for more advanced, efficient, and flexible systems, which can overcome these challenges and provide more reliable and sustainable solutions.

IV.PROPOSED SYSTEM

The proposed system aims to offer an enhanced solution for animal repelling by leveraging Radio Frequency (RF) technology, instead of traditional ultrasonic waves. This system is designed to overcome the limitations of existing ultrasonic repellent devices, providing a more effective, versatile, and user-friendly solution for areas such as farms, highways, residential zones, and wildlife sanctuaries. The core of this system is an IoT-based animal repellent device

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that uses RF signals broadcast through an antenna to deter animals, with added features for remote control, environmental monitoring, and real-time updates.

4.1.RF Technology with Antenna

Unlike traditional ultrasonic repellents, the proposed system uses RF signals emitted through an antenna to repel animals. RF signals have a significantly greater range and can propagate through obstacles such as walls, trees, and fences, providing broader coverage. This ensures that the device can effectively cover large areas, such as farms or highways, without requiring a direct line of sight to the target area.

4.2.Solar-Powered System

The proposed system is powered by a solar panel, ensuring that the device remains operational in remote or off-grid locations. The solar panel charges a battery, which stores energy to power the device even during periods of low sunlight. This eco-friendly solution eliminates the need for traditional power sources or frequent battery replacements, making the system more sustainable and cost-effective.

4.3.Microcontroller

The central controller of the system is the ESP32 microcontroller. This microcontroller manages all components of the system, including the RF module, sensors, and communication between the mobile application and the device. The ESP32 also facilitates Wi-Fi and Bluetooth communication, enabling real-time control and monitoring of the system through a mobile app. It processes commands received from the app, adjusts the frequency emitted by the RF module, and provides updates on system status.

4.4.Mobile Application for Remote Control

The system integrates a mobile application that allows users to remotely control the device. The app enables users to select the target animal species and adjust the frequency of the RF signals accordingly. The application is designed to be user-friendly, providing an intuitive interface for managing the device's functions. In addition to controlling frequencies, users can monitor the device's battery level, system health, and receive alerts on device status (e.g., power issues, error notifications). This provides full control and flexibility for users, enabling them to manage the system from anywhere.

4.5.Animal Frequency Selector

The proposed system allows users to adjust the frequency emitted by the RF module based on the animal species they wish to repel. The mobile app enables users to select from a list of preset frequencies optimized for different animals. For example, frequencies effective for deer may differ from those effective for rodents. The frequency selector is an essential feature that adds flexibility and customization, ensuring the system is effective against a wide range of animals.

4.6.Environmental Sensor

The proposed system includes sensors that monitor the environment in real-time. These sensors can detect temperature changes and rainfall, allowing the system to adjust its operations accordingly. For instance, in rainy weather, the system can automatically adjust its output to maintain its effectiveness, as weather conditions can impact the propagation of RF signals. These sensors provide valuable data to the microcontroller, which then makes real-time decisions about system behaviour.

4.7.Data Collection and Monitoring

The system continuously collects data about its operation and the surrounding environment. This data is sent to the mobile app, where users can track performance metrics, such as frequency levels, battery status, and sensor data. The collected data is essential for users to ensure the system operates efficiently and can be analyzed for further improvements or optimizations.

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V.METHODOLOGY

5.1.Problem Identification

The project addresses the issue of animals intruding into restricted areas, such as farms, highways, or residential zones, causing damage or posing risks. Conventional methods, such as ultrasonic repellent devices, have limited range and coverage. This project introduces an IoT-based solution using RF technology for wider coverage and efficient animal deterrence.

5.2.Frequency Data Collection and Analysis

To ensure the system effectively repels animals, research is conducted to identify the RF frequencies that different animals are sensitive to. These frequencies are non-harmful but effective in deterring animals. Test various RF frequencies to determine the most effective ranges for specific animals. Record and store the frequency data for implementation.

5.3.Hardware Selection and System Design

The hardware components required for the device are selected based on functionality, cost, and sustainability.
Microcontroller (ESP32): For processing and controlling the system.
RF Module and Antenna: To generate and broadcast the required RF frequencies over a wide range.
Sensors: Include temperature and rain sensors for environmental monitoring.
Solar Panel: Provides sustainable power to charge the battery.
Rechargeable Battery: Ensures uninterrupted power supply.

5.4.Mobile App Development

A mobile application is developed to provide users with a convenient way to control and monitor the device.
Key Features: Selection of target animals to adjust frequencies. Real-time notifications and alerts for battery status or system issues. Historical logs of device usage and performance. Manual frequency adjustment options for user-defined applications.
Communication: The app connects to the device via GSM or Wi-Fi for remote control.

5.5.Testing and Validation

The device is tested under various conditions to ensure reliability and effectiveness:
Field Tests: Deploy the device in areas with frequent animal intrusion.
Performance Metrics: Measure the effectiveness of RF frequencies, device range, and user control features.
Feedback: Gather user feedback to refine the system.

5.6.Scalability and Expansion

The system is designed to be scalable for future enhancements: Add support for more animal species by updating frequency data. Improve range and power efficiency with advanced RF modules. Expand features in the mobile app, such as integration with AI cameras for animal detection.

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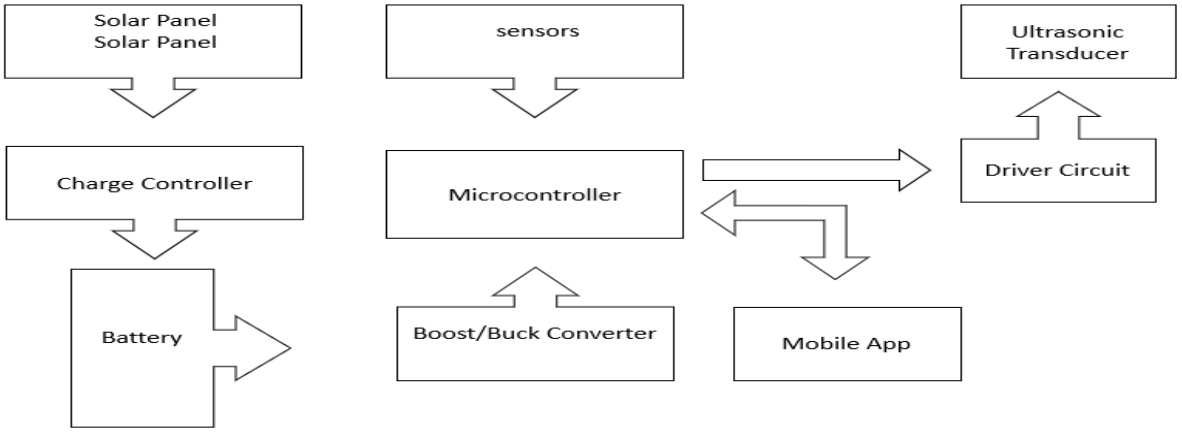

Fig 2: Working flow of IoT based animal repellent device using RF technology and mobile app control

5.7.RF Signal Transmission

The RF transceiver generates the selected frequency and transmits it via the antenna. The signal propagates over a large area, effectively repelling animals within the coverage range.

5.8.Power Management

The solar panel charges the battery during the day, ensuring that the device remains operational at all times. The device uses minimal power, making it energy-efficient and sustainable.

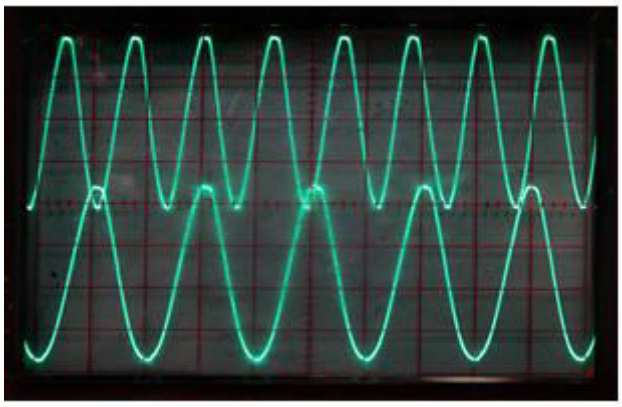

Fig 3: Cathode Ray Oscilloscope output

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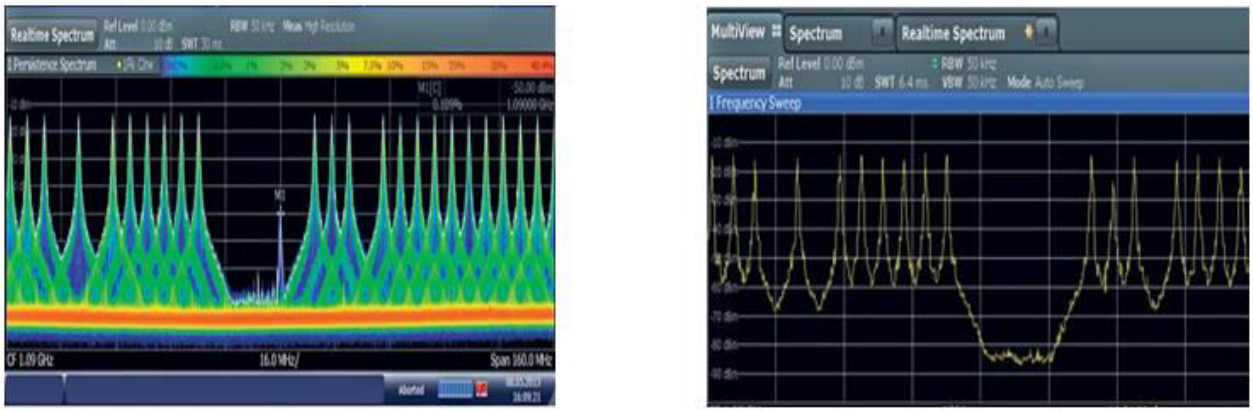

Fig 4: This is spectrum analysing wave forms

5.9.Status Updates via GSM

The GSM module sends periodic status updates to the user's phone, notifying them of system health, battery levels, or any operational issues (e.g., low power, signal errors). The user can also receive alerts if the device requires attention.

VI.CONCLUSION

By replacing ultrasonic waves with RF signals, the system enhances the range and effectiveness, ensuring a broader and more reliable coverage area. The integration of an antenna further strengthens this capability, allowing the system to work efficiently even in obstructed or large areas. The mobile application empowers users to remotely control and customize the system, adjusting frequencies to target specific animals and receiving real-time status updates and alerts. This provides flexibility and ease of use, offering a tailored approach for different animal species. Additionally, the inclusion of environmental sensors such as temperature and rain detection ensures that the system can adapt to changing conditions, maintaining its effectiveness in various weather environments. The solar-powered design enhances the sustainability of the system, making it ideal for remote locations where traditional power sources are unavailable. The IoT-based connectivity provides users with continuous monitoring, allowing for proactive maintenance and operation management, thus improving the system's overall reliability. Its versatility, cost-effectiveness, and scalability make it suitable for various applications, including agriculture, wildlife management, and urban environments, contributing to a safer, more sustainable approach to animal control. Overall, the proposed RF-based animal repellent system offers a modern, flexible, and efficient solution to the growing challenges of animal intrusion, meeting the diverse needs of users while ensuring minimal environmental impact.

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