

Iot Based Lowcost Rodent Repelling Device Using Ultrasonic Frequency

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ABSTRACT

This project focuses on the development of an IoT-based, cost-efficient rodent repelling device leveraging ultrasonic frequency technology. The system is designed to incorporate an ESP8266 module for wireless connectivity, enabling seamless interaction with the Thing Speak web server for data monitoring and analysis. Key hardware components include an Active Buzzer for audible notifications, an Ultrasonic Distance Sensor for precise rodent detection, and an IR LED Proximity Sensor for enhanced operation in varied lighting conditions. A SIM800L sends and receives SMS Alert to the user mobile, while a Servo Motor provides dynamic movements to effectively deter rodents. The 16x2 LCD Display offers real-time updates on system activities, while mobile integration delivers instant message alerts to users for enhanced control and responsiveness. By utilizing ultrasonic frequencies intolerable to rodents, the device operates in a manner safe for humans and pets. This innovative solution is designed to address rodent infestations in an eco-friendly, efficient, and scalable way, making it ideal for residential, agricultural, and commercial applications.

Keywords: Esp8266 module, Active Buzzer, Ultrasonic Distance Sensor, Sim800L Mini GSM/GPRS Module, IR LED Proximity Sensor, LCD 16*2 Display, Servo motor.

INTRODUCTION

Rodent infestations pose significant challenges across residential, agricultural, and commercial environments, impacting hygiene, food safety, and structural integrity. Traditional rodent control methods often rely on chemical agents or manual interventions that may be harmful to the environment, costly, or inefficient. In response to this pressing issue, this project proposes the development of an IoT-enabled, low-cost rodent repelling device.

The system leverages ultrasonic frequency technology, which is safe for humans and pets while being intolerable to rodents. Key components include an ESP8266 module for efficient wireless connectivity and integration with the Thing Speak web server for real-time data tracking and analysis. Additional hardware features such as an Active Buzzer for audible alerts, an Ultrasonic Distance Sensor for precise rodent detection, a mini GPRS Module for SMS Alerts, and an IR LED Proximity Sensor for low-light operation ensure robust functionality. A Servo Motor introduces dynamic movement to deter rodents,

while a 16x2 LCD Display provides users with real-time system status updates. Furthermore, mobile integration enables instant alerts, allowing users to stay informed and take timely action. Powered by a reliable 12V or 5V power supply, this innovative solution aims to be cost-effective, scalable, and environmentally friendly. By combining IoT and advanced detection technologies, this project offers a modern, efficient, and eco-friendly approach to addressing rodent infestations effectively.

LITERATURE REVIEW

Ultrasonic Frequency Technology in Pest Control

Ultrasonic frequencies are widely used in pest control due to their ability to repel rodents without harming humans or pets. Studies indicate that frequencies between 30 kHz and 70 kHz are particularly effective. Research highlights the importance of varying frequencies to prevent rodents from adapting to static sounds.

IoT Integration in Smart Devices

IoT platforms like Thing Speak enable real-time data monitoring and analysis, making them ideal for applications requiring remote control and alerts.

The ESP8266 module is a popular choice for IoT devices due to its low cost, Wi-Fi capabilities, and compatibility with cloud platforms.

Mobile alerts enhance user responsiveness by providing instant notifications about rodent activity. This feature is critical for timely intervention.

Environmental and Practical Applications

Ultrasonic rodent repelling devices are eco-friendly alternatives to chemical repellents, which can be harmful to humans and the environment.

These devices are suitable for residential, agricultural, and commercial settings, addressing rodent infestations comprehensively.

EXISTING METHOD

Static IoT Ultrasonic Repeller

This design uses the ESP8266 module to establish IoT connectivity, allowing remote monitoring. The ultrasonic distance sensor continually checks for rodent presence. When an object is detected within range, the system simultaneously activates an ultrasonic emitter (set to a fixed repelling frequency) and an active buzzer as an added deterrent. The LCD 16x2 displays real-time system status. With its fixed ultrasonic frequency and static orientation, rodents may eventually acclimate to the repelling sound.

Mini GSM module based Repeller

In this project, the ESP8266 connects the device to a cloud dashboard. Both an ultrasonic sensor and an IR LED proximity sensor work in tandem to detect rodent activity more reliably. Once confirmed by sensor fusion, the Mini GPRS Module receives the rodent detect information and sends to user's mobile as an SMS alert, the system triggers the ultrasonic repeller alongside the active buzzer. The LCD shows a status update and detection log.

Operating multiple sensors and a camera concurrently can lead to higher power consumption and requires careful calibration to avoid false triggers.

Adaptive Servo-Based Directional Repeller Here, the ultrasonic emitter is mounted on a servo motor that rotates to scan the surrounding area continuously. An ultrasonic sensor detects approaching rodents, triggering the buzzer and ultrasonic emitter. This movement prevents rodents from finding safe zones,

while the LCD displays detection counts and current scan direction. The ESP8266 transmits periodic status updates to a remote monitoring system. Moving parts like the servo may wear over time, and mechanical adjustment might slow down reaction speed under rapid rodent movement.

Dynamic Frequency Modulator Rodent Repeller This design focuses on preventing rodent adaptation by dynamically varying the ultrasonic frequencies. Based on a preset algorithm running on the microcontroller, the ultrasonic emitter cycles through several frequencies once the ultrasonic sensor or IR LED confirms a near-field intrusion. An active buzzer adds an extra layer of deterrence. The LCD provides a user-friendly interface to view current frequency settings and operational status, while the ESP8266 module supports remote adjustments and logging. Lacks a mechanical rotation mechanism, so the directional coverage is limited if deployed in a fixed position.

Robotic Patrol Rodent Interceptor

In this more ambitious design, a small robotic platform patrolling the area carries the rodent repelling system. The ultrasonic and IR sensors detect rodents as the robot moves. A servo equipped ultrasonic emitter ensures that no blind spots exist by scanning continuously, and the active buzzer adds auditory deterrence. Data is sent in real time via the ESP8266, with local updates shown on the LCD for real-time monitoring. Increased mechanical and processing complexity can lead to higher maintenance demands, and the robotic movement requires robust obstacle avoidance.

PROPOSED SOLUTION

The system is an IoT-based rodent repelling device that uses ultrasonic frequency modulation to deter pests. The central controller is an ESP8266 module, enabling Wi-Fi connectivity and remote monitoring. An Ultrasonic

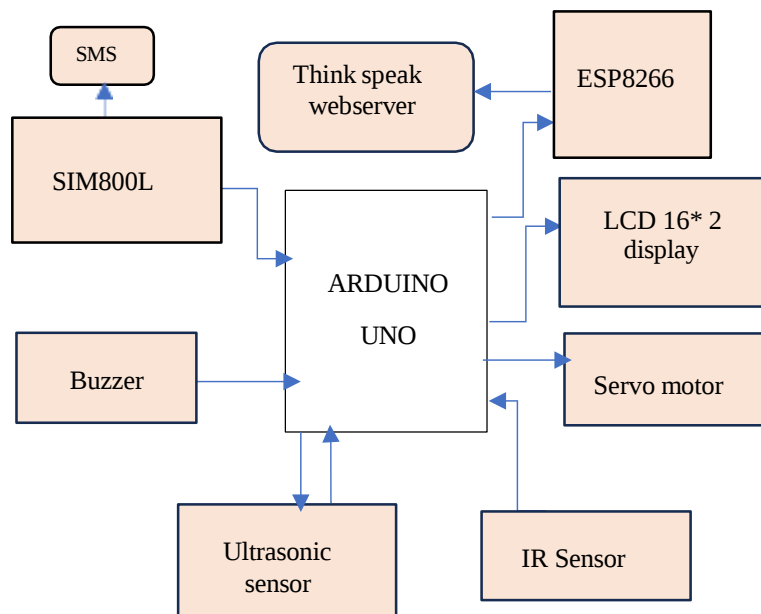


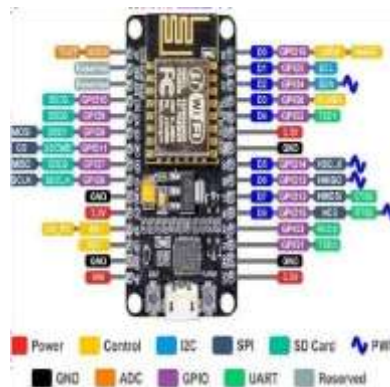
Fig4.1: Block diagram

Distance Sensor continuously scans the environment for moving objects. An IR LED Proximity Sensor confirms close-range motion, ensuring accurate rodent detection. Both sensors work together using sensor fusion to reduce false alarms. Upon confirmed detection, the device activates an ultrasonic

emitter that produces modulated high-frequency sound waves. A Servo Motor rotates the ultrasonic emitter, ensuring full 360° area coverage. The device transmits real-time alerts through Mini GPRS Module (SIM800L) and data via the ESP8266 to a cloud- based dashboard. The LCD 16×2 Display provides on-site feedback, showing sensor readings and system status. The system uses a smart algorithm to activate repelling only when multiple sensor thresholds are met. Overall, the integrated solution offers robust rodent detection, adaptive repelling, energy efficiency, and remote adjustability for an optimized pest control strategy.

HARDWARE COMPONENTS

Esp8266 NodeMCU



The NodeMCU ESP8266 is a low-cost, Wi-Fi-enabled microcontroller, ideal for IoT applications like a rodent repelling device. It can connect to a PIR sensor (like the HCSR501) to detect motion and trigger a repelling mechanism (e.g., ultrasonic sound or LED flash). With Wi- Fi capabilities, the ESP8266 can send alerts or enable remote control through a smartphone or web app. Its low power consumption and affordability make it suitable for scalable, cost-effective rodent repelling solutions.

LCD 16*2 display



A 16x2 LCD display uses liquid crystals to modulate light and display information. The display consists of two rows with 16 characters each, controlled by an HD44780 controller. It's commonly used in embedded systems and IoT projects due to its simplicity and effectiveness.

IR LED Proximity sensor



An IR LED-based proximity sensor detects objects by emitting infrared light from an IR LED and measuring the reflection. The sensor has an IR receiver that captures the reflected light and sends it to a

processing circuit. When an object is near, the reflected light increases, triggering a signal output. These sensors are commonly used in applications like obstacle detection, automatic doors, and object counters. They are cost-effective, easy to implement, and work well in various environments.

Ultrasonic frequency sensor



An ultrasonic frequency sensor is an electronic device that measures the distance to a target object using ultrasonic sound waves.

Transmitter: The sensor emits ultrasonic sound waves using a piezoelectric crystal

Receiver: The sound waves bounce off the target object and return to the sensor.

Distance Calculation: The sensor measures the time it takes for the sound waves to travel to the object back where DD is the distance, TT is the time, and CC is the speed of sound (approximately 343 meters per second).

Servo motor



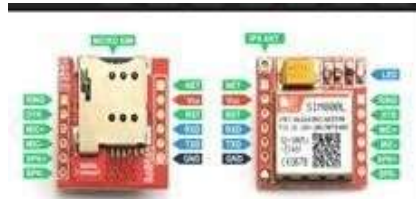
The servo motor converts electrical signals into precise rotational motion, allowing controlled movement of attached components. In our rodent repelling device, it rotates the ultrasonic emitter to direct sound waves over a 360° area. This sweeping motion ensures that no blind spots remain, effectively covering all directions for rodent deterrence. The servo motor receives commands from the ESP8266 module, adjusting its angle based on sensor inputs and detection events.

SOFTWARE

Arduino IDE Installation & code dump

- **Download IDE:** Get the Arduino IDE from the official website.
- **Install IDE:** Run the installer (Windows), drag to Applications (macOS), or extract and execute (Linux).
- **Accept License:** Agree to the license and install required drivers.
- **Launch IDE:** Open the Arduino IDE on your computer.
- **Connect Board:** Plug your Arduino into your computer via USB.
- **Select Board/Port:** In the Tools menu, choose the correct board model and port.
- **Open/Write Code:** Create your sketch or open an example like "Blink."
- **Compile Code:** Click the "Verify" button to compile and check for errors.
- **Upload Code:** Click the "Upload" button to transfer the code to the board.
- **Test Functionality:** Confirm the board runs the program

SIM800L



Mini GSM/GPRS module

SIM800L is a miniature cellular module which allows for GPRS transmission, sending and receiving SMS and making and receiving voice calls. Low cost and small footprint and quad band frequency support make this module perfect solution for any project that require long range connectivity. After connecting power module boots up, searches for cellular network and login automatically. On board LED displays connection state (no network coverage - fast blinking, logged in - slow blinking).

ADVANTAGES

Affordability: A low-cost device is accessible to a wide range of users, making rodent control feasible without a significant financial burden. This is especially useful for households or small farms.

Low Maintenance: Once installed, many of these devices require minimal maintenance. Unlike traps that need regular checking, ultrasonic repellents generally work continuously as long as they have power.

Prevents Property Damage: By keeping rodents at bay, these devices help prevent the damage that rodents can cause to wires, insulation, furniture, and stored food, which could lead to costly repairs.

Low Energy Consumption: Most low-cost electronic repellents consume minimal energy, making them economical to operate in the long term.

APPLICATIONS

Smart Homes: The device can be installed in homes to continuously monitor and repel rodents. When a rodent is detected, the system not only repels it with ultrasonic waves but also sends an SMS alert to your mobile phone, letting you know about the event immediately.

Commercial Kitchens and Restaurants: In food service areas where hygiene is paramount, the device can protect kitchens by detecting and repelling rodents. An SMS alert notifies the staff, ensuring timely action before any contamination occurs.

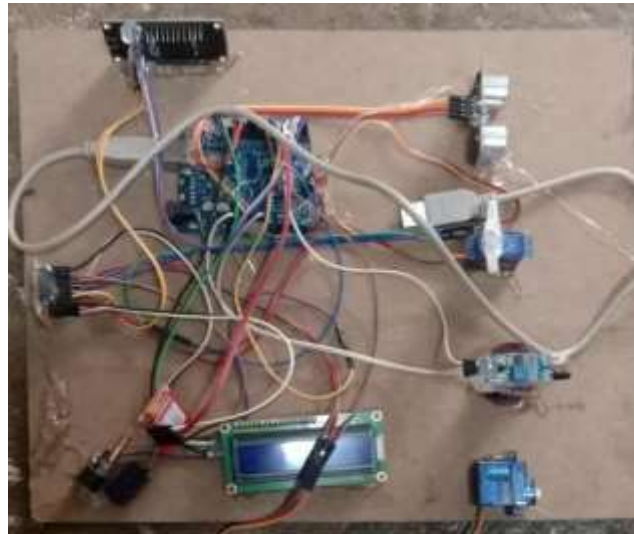
Warehouses and Storage Facilities: Food storage areas or warehouses benefit from proactive pest control. The device monitors the space, repels intruders with sound and movement, and sends SMS alerts to managers, minimizing potential damage to stored products.

Food Processing Plants: Maintaining a pest-free environment is crucial for safety and quality. Integrated sensors and alerts help operators quickly respond to any rodent activity, keeping production sanitary.

Hospitals and Laboratories: For places that need extra care with cleanliness, this device offers round-the-clock monitoring. The SMS alert feature ensures that hospital staff or lab technicians receive instant updates, preserving a sterile environment.

Agricultural Settings: In farms or grain storage facilities, rodents are a common threat. The device deters pests using ultrasonic signals and rotating coverage, alerting farmers via SMS so they can take remedial action before pests spread.

EXPERIMENTAL RESULTS



Experimental tests demonstrated that the ultrasonic distance and IR LED sensors, working together, accurately detected rodent movement with minimal false positives. Once detection occurred, the dynamic ultrasonic emitter and active buzzer activated immediately to repel the rodents, as confirmed by consistent SMS alerts. The Arduino UNO connects all components connections which acts as microcontroller while the ESP8266 module reliably transmitted real-time data to both the cloud and local LCD display. When the object detected Mini GPRS Module helps to send message alert to mobile The servo motor efficiently rotated the emitter, ensuring 360° coverage and further validating the system's comprehensive protection during trials

FUTURE SCOPE

An IoT-based rodent repelling device is extensive, particularly as technology advances and smart home as well as industrial automation systems grow more prevalent. One promising direction is the integration of machine learning and artificial intelligence, where data gathered from the ultrasonic distance sensor, IR LED sensor,. Over time, these systems could learn the typical movement patterns of rodents in different environments and adjust frequency modulation automatically to increase effectiveness. Additionally, enhanced data analytics on a cloud platform would enable predictive maintenance, ensuring the device remains operational by alerting users to component wear or environmental changes that affect performance.

Another future development is the expansion of connectivity and integration with broader smart ecosystem networks. The ESP8266 module could be upgraded to support more robust and secure communication protocols, allowing seamless integration into home automation systems or municipal pest control networks. Incorporating energy harvesting techniques, such as solar panels or kinetic energy capture, could further improve the device's sustainability, making it viable for long-term outdoor deployments. Moreover, the addition of new sensors—like thermal imaging or advanced motion detectors—could further reduce false positives and enable the system to distinguish between various pests. This holistic approach to IoT-based pest control promises not only greater efficiency and reliability but also a proactive method to safeguard environments from rodent infestations, paving the way for smarter, data-driven urban and rural pest management solutions.

CONCLUSION

The IoT-based rodent repelling device represents a significant leap forward in pest control technology by integrating multiple advanced components into a cohesive system. Leveraging the ESP8266 module, the device enables seamless remote monitoring and control, while combining the ultrasonic distance sensor and IR LED proximity sensor via sensor fusion ensures accurate rodent detection. The dynamic modulation of ultrasonic frequencies—enhanced by the rotating servo mechanism— ensures comprehensive 360° coverage, effectively deterring rodents without allowing them time to adapt. Complementary features, such as the active buzzer for audible warnings, the SIM800L gives SMS alert to the Mobile, and the LCD 16×2 display for on-site feedback, contribute to a robust, user-friendly interface. Overall, this smart, energy-efficient design not only maximizes rodent repelling effectiveness but also sets a strong foundation for future developments in automated, data-driven pest management solutions.

REFERENCES

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2. **Islam, Rafiul (n.d.)** – *Design and Development of a Variable Ultrasonic Frequency Generator for Rodents Repellent*. This work focuses on building an ultrasonic frequency generator that varies its output, which is useful for preventing rodents from getting used to a constant tone.
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4. **ESP8266 Documentation by Espressif Systems**. Official documentation for the ESP8266 module, which covers setting up Wi-Fi connectivity and interfacing with sensors—critical for remote IoT control.
5. **Component Datasheets (Ultrasonic Sensor, IR LED Proximity Sensor, LCD 16×2 Display, Active Buzzer, Servo Motor)**. Manufacturer datasheets provide technical details, wiring instructions, and performance specifications for each component used in the device.
2. These references provide a mix of academic insights, practical project experiences, and technical details that can help you understand both the theory and practical application behind building an IoT-based rodent repelling device.