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Animal Deterrent System for Domestic Areas

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Abstract- Animal intrusion in domestic areas is an increasing concern due to urbanization and reduced natural habitats. This project presents an Animal Deterrent System for Domestic Areas employing dual frequency ultrasonic sound to enhance repellent effectiveness. The system generates ultrasonic waves that alternate between two frequency ranges to prevent animal adaptation. In addition to ultrasonic deterrence a high intensity LED flashing module is incorporated to provide a visual stimulus that further discourages animal entry, particularly during low light and night time conditions. The system controls frequency switching and LED flashing operations to ensure reliable performance with low power consumption. The proposed system is non-lethal, eco-friendly and suitable for residential environments. Experimental observations demonstrate improved deterrence compared to single frequency systems, making the proposed approach a practical solution for domestic animal intrusion control.

Keywords - STM32 Microcontroller, GSM Module (SIM800L), NEO-6MGPS Module, 18650 Li-ion Battery,

I. INTRODUCTION

Human–animal interaction in domestic and semi-urban areas has become increasingly common due to urban expansion and habitat reduction. Stray dogs, monkeys, wild boars, and other animals frequently enter residential colonies, farms, and household surroundings in search of food and shelter. This often results in property damage, crop destruction, disturbance during night hours, and safety risks for children and elderly people. Traditional preventive methods such as fencing, chemical repellents, or physical force are either harmful, expensive, or not environmentally friendly. Therefore, there is a strong need for a safe, humane, and technology-based solution to address this issue effectively.

The Animal Deterrent System for Domestic Areas is designed to provide a non-lethal and eco-friendly method to prevent animals from entering restricted zones. The primary working principle of this system is based on ultrasonic sound generation. The device produces high-frequency ultrasonic waves in the range of 20–40 kHz. These frequencies are generally inaudible to humans but are highly uncomfortable for animals. When exposed to such sound waves, animals naturally move away from the area without experiencing physical harm. This ensures both human safety and animal welfare.

The system is built using a PVC pipe-based enclosure, which acts as the mold and outer body of the device. The PVC pipe is heated and shaped to form a compact and durable structure. The outer surface is laminated with a PVC sheet to enhance strength, weather resistance, and appearance. This mechanical design makes the device lightweight, portable, and suitable for outdoor domestic environments such as house entrances, gardens, terraces, and farm boundaries.

The internal circuitry consists of a microcontroller unit, ultrasonic sound generator module, GPS module, GSM communication module, rechargeable 18650 lithium-ion battery, LED indicators, and a panic button. The microcontroller serves as the control unit, coordinating all system operations. When the device is powered ON, it remains in idle mode to conserve energy. Upon pressing the panic button, the ultrasonic sound generator activates and emits dual-frequency sound waves. Simultaneously, LED indicators begin flashing to provide visual deterrence, especially during night-time conditions.

In addition to sound deterrence, the system includes a GPS module to capture real-time location coordinates. The GSM module is used to send alert messages to the user's mobile phone, including an SMS notification and location link if required. This feature enhances security by allowing remote awareness and monitoring. The device operates on a rechargeable battery, making it independent of continuous external power supply and suitable for portable use.

The system also includes a timeout mechanism. After a specific duration or manual switching OFF, the ultrasonic sound and LED indicators stop automatically, and the device returns to idle mode. This improves energy efficiency and extends battery life. This system is designed with simplicity and user-friendliness in mind, allowing easy installation and operation without technical expertise. The compact structure and durable PVC enclosure ensure long-term reliability in various weather conditions. By integrating electronic control with practical mechanical design, the project highlights the importance of smart domestic safety solutions in modern residential environments.

II. LITERATURE REVIEW

Kumar et al. highlighted the increasing problems caused by stray and wild animals entering residential and agricultural areas. Their study focused on ultrasonic-based repellent systems operating above the human audible range. The researchers explained that high-frequency sound waves disturb animals without causing physical harm. They emphasized that ultrasonic deterrent systems are environmentally friendly, safe for humans, and require low maintenance. The study concluded that ultrasonic technology is an effective and humane solution for domestic animal control.

Sharma et al. proposed a smart ultrasonic animal repellent device controlled by a microcontroller. The system activates automatically when motion is detected, thereby reducing unnecessary power consumption. Their research showed that programmable controllers allow frequency variation and timing control to prevent animal adaptation. The authors highlighted that automation improves system reliability and efficiency in domestic environments. The proposed design demonstrated better performance compared to manually operated repellent systems.

Lee et al. investigated the behavioral response of animals exposed to ultrasonic frequencies between 20 kHz and 40 kHz. The study analyzed sensitivity levels of different animals to various frequency bands. The researchers concluded that variable frequency generation prevents animals from becoming accustomed to a fixed tone. Experimental observations indicated that certain animals respond more strongly to specific frequency ranges. The study emphasized the importance of adjustable frequency systems in improving long-term deterrent effectiveness.

Patel et al. presented a dual-frequency ultrasonic generator designed to repel dogs and small wild animals. Their research demonstrated that alternating frequency output increases disturbance and reduces adaptation. The authors discussed important design aspects such as oscillator stability, amplifier circuits, and proper transducer driving techniques. The study confirmed that multi-frequency systems provide improved efficiency compared to single-frequency devices, making them more suitable for domestic and outdoor applications.

Rao et al. reviewed different non-lethal wildlife control techniques used in urban and rural regions. The authors compared electric fencing, chemical repellents, and ultrasonic devices based on safety, cost, and environmental impact. Their findings suggested that ultrasonic systems offer safer operation and easier installation. The review also pointed out that chemical repellents may cause environmental pollution and electric fencing requires higher maintenance. Ultrasonic methods were recommended as practical solutions.

Wilson et al. highlighted the benefits of integrating sound and light deterrent mechanisms in animal repellent systems. Their study showed that combining ultrasonic waves with flashing LED lights

enhances effectiveness, especially during nighttime. The researchers explained that multi-sensory disturbance creates stronger behavioral reactions in animals. The system demonstrated improved performance in open domestic areas. The study concluded that hybrid deterrent methods increase protection efficiency.

Zhang et al. proposed a portable battery-operated animal deterrent device for domestic use. The study emphasized low-power embedded system design to extend battery life. Their research highlighted the importance of compact structure and lightweight enclosure for easy installation. The authors recommended rechargeable batteries and efficient power management circuits. Experimental results confirmed that portable ultrasonic systems are suitable for household security and small-scale protection applications.

Natarajan et al. investigated the influence of environmental conditions such as wind, humidity, and physical obstacles on ultrasonic wave propagation. The study found that environmental factors can reduce effective coverage area. The researchers emphasized proper enclosure design and directional sound projection to enhance performance. Weather-resistant materials were recommended for outdoor installations. The study concluded that environmental considerations are essential for reliable operation.

Brown et al. presented a GSM-based animal intrusion alert system integrated with ultrasonic deterrent technology. The system sends real-time notifications to users when animal movement is detected. The study demonstrated that communication modules improve monitoring and response capability. Remote alert systems were found to enhance user awareness and domestic security. The integration of wireless communication increases system functionality and practical usability.

III. DESCRIPTION OF THE EXISTING SYSTEM

In In domestic areas, especially residential colonies and house surroundings, animal intrusion particularly by stray dogs has become a common problem. The existing systems used to control or prevent such intrusion mainly rely on traditional and manual methods. Fig.1 shows electric fencing, chemical repellents, physical barriers, manual guarding, and basic ultrasonic repellent devices. Electric fencing is sometimes used in larger properties; however, it is costly, requires continuous power supply, and may pose safety risks to both animals and humans. Chemical repellents are also commonly used, but their effectiveness reduces over time due to weather conditions such as rain and wind. Additionally, repeated application increases maintenance cost and may cause environmental impact.

Physical barriers like metal gates and fences provide limited protection and cannot always prevent smaller animals from entering. Manual guarding is labor-intensive and unreliable, particularly during night hours. Basic ultrasonic devices are available in the market, but most operate at a fixed frequency, allowing animals to gradually adapt to the sound. Many existing systems lack portability, making them unsuitable for personal protection during walking or bike travel. Most conventional devices do not provide real-time alert or communication features. Hence, there is a need for a more intelligent

Fig. 1. Existing system of Transformer rewing system

Moreover, existing systems generally lack intelligent control, automated activation, and remote alert features. They do not provide real-time notification or location tracking. These limitations highlight the need for a smarter, safer, and more efficient animal deterrent system for domestic areas.

IV. CHALLENGES IN THE EXISTING SYSTEM

In domestic and urban areas, stray dog disturbance has become a common safety issue, particularly during bike travel, walking, jogging, and night-time movement. Existing animal control systems are mostly fixed installations such as electric fencing, stationary ultrasonic devices, or physical barriers. These systems only protect a specific location and do not provide personal safety when individuals are moving in open streets.

During bike travel, stray dogs often chase two-wheelers due to the sound and motion of the vehicle. This can create panic for riders and may lead to loss of control or accidents. Similarly, pedestrians and joggers frequently experience sudden barking or aggressive behavior from street dogs, especially in poorly lit areas. Existing solutions like shouting, using sticks, or throwing objects are unreliable and may increase aggression instead of preventing it.

Another major challenge is the absence of portable protection devices for individuals. Most available deterrent systems are not designed for handheld or wearable use. Furthermore, many basic ultrasonic devices operate at fixed frequencies, allowing dogs to gradually adapt to the sound over time, reducing effectiveness.

V. PROPOSED SYSTEM

The The proposed system, titled *Animal Deterrent System for Domestic Areas*, is designed to provide a portable, safe, and intelligent solution to prevent stray dog disturbance during walking, bike travel, jogging, and other daily activities. Unlike existing fixed systems, the proposed device is compact and handheld, allowing users to carry it easily for personal protection.

The system operates based on ultrasonic sound generation in the frequency range of 20–40 kHz. These high-frequency sound waves are inaudible to humans but uncomfortable for dogs and other animals. When activated, the ultrasonic sound creates a disturbance that causes the animal to move away without causing any physical harm. This ensures a humane and non-lethal approach to animal control. The device is controlled using a microcontroller unit that manages the overall operation. In normal conditions, the system remains in idle mode to conserve battery power. When the user presses the panic button during a threatening situation, the ultrasonic sound generator is activated instantly. At the same time, LED indicators begin flashing to provide visual warning, especially useful during night-time.

Additionally, the proposed system integrates a GSM module to send an alert message to the user's registered mobile number.

The alert can include a notification indicating activation of the device. If required, a GPS module can also be included to share location details for enhanced safety monitoring. The entire system is powered by a rechargeable lithium-ion battery, making it portable and energy efficient. The enclosure is fabricated using a PVC pipe mold with laminated outer covering, ensuring durability and weather resistance. Furthermore, the system is designed with low power consumption circuitry to extend battery life and ensure long operational duration. The compact structure makes it suitable for mounting on bikes or carrying in hand during travel.

The proposed design focuses on user-friendly operation, quick response time, and reliable performance under various environmental conditions. Overall, the proposed system offers automation, portability, real-time alert capability, and improved effectiveness compared to existing methods, making it suitable for domestic and street-level personal safety applications.

Block Diagram:

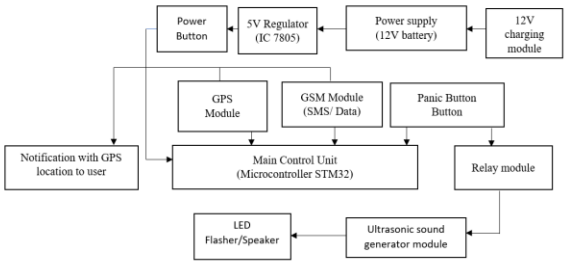

Fig. 2. Block diagram of the Proposed System.

The block diagram of the Animal Deterrent & Safety Device represents the overall functional flow of the system shows in the fig.2. The main component of the system is the Main Control Unit (Microcontroller / MCU), which acts as the brain of the device. It controls and coordinates all input and output operations. The system includes a Panic Button, which serves as a manual activation switch. When the user presses the panic button during a threatening situation, a signal is sent to the microcontroller. Additionally, a Sound Sensor (Input Unit) can be used to detect sudden barking or high noise levels, triggering automatic activation. The GPS Module is connected to the microcontroller to obtain real-time location data (latitude and longitude). location information is processed and forwarded to the communication unit when required.

The GSM Module (SMS/Data) is responsible for sending alert messages to a registered mobile number. Once activated, it transmits an SMS notification along with the location link to the recipient phone for safety monitoring. The microcontroller activates the Trigger Logic Sound (20–40 kHz) block, which generates control signals for the ultrasonic system. These signals are fed to the Ultrasonic Generator (20–40 kHz), producing high frequency sound waves that repel stray dogs without causing harm. An LED Flasher / Indicator block provides visual warning during activation, especially useful in night conditions. The entire system is powered by a Battery / Power Supply (Li-ion with charging circuit), which supplies regulated voltage to all blocks. Thus, the block diagram clearly shows the signal flow from input units to processing, output activation, communication, and power supply, ensuring effective and portable animal deterrent operation.

Flow Chart:

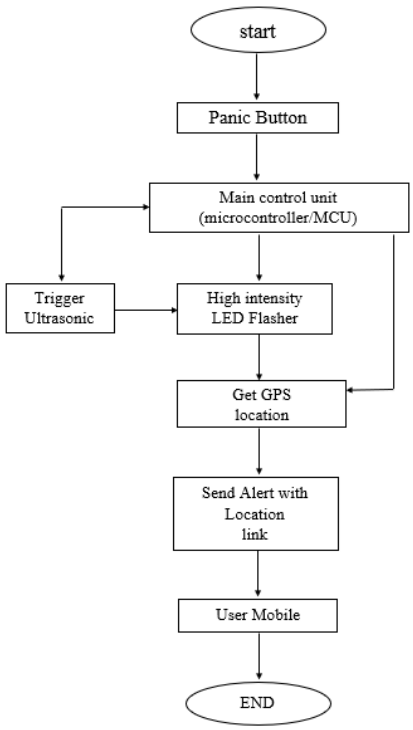

Fig.3. Flow Chart of Proposed System.

Hardware Implementation:

The hardware implementation of the Animal Deterrent System involves integrating all electronic modules into a compact and portable structure. The STM32 microcontroller is programmed and interfaced with the ultrasonic generator, GSM module, push button, and power supply circuit. The Li-ion battery, charging module, and 7805 voltage regulator provide stable power to all components. The ultrasonic transducer is connected through a driver circuit for proper signal amplification. All components are assembled on a PCB and enclosed inside a PVC pipe body with laminated covering. Proper wiring, testing, and voltage verification ensure reliable system performance and safe operation.

Hardware components:

[i] STM32: The STM32 microcontroller serves as the main control unit of the system, as shown in Fig. 4. It processes input signals, controls the ultrasonic generator, and manages communication modules such as GSM and GPS. The microcontroller coordinates all operations and ensures proper synchronization between different hardware components.

Fig. 4. STM32

[ii] Single Channel Relay Module: The single channel relay module is an electrically operated switch used to control high-voltage devices using low-voltage signals from the STM. It allows the microcontroller to safely control the device shown in the fig.5. The relay provides electrical isolation between the control circuit and power circuit, ensuring safe reliable motor switching.

Fig. 5. Relay Module

[iii] Li-Ion Battery: The Li-Ion Battery shown in the fig. 6. It serves as the primary power source of the system. It offers high energy density, lightweight structure, and rechargeable capability, making it ideal for portable devices. It ensures long backup time and supports mobility during walking or bike travel.

Fig. 6. Li-Ion Battery

iv] Ultrasonic Sound Generator: The Ultrasonic Generator produces high-frequency sound waves in the range of 20–40 kHz, which are inaudible to humans but uncomfortable for dogs. This helps repel animals without causing physical harm. The GSM/GPRS Module enables wireless communication for sending alert messages. Module shown in fig.7. such as SIM800L are used to transmit SMS notifications to a registered mobile number during emergency activation.

Fig. 7. Ultrasonic Sound Generator

[v] 7805 Voltage Regulator IC: The 7805 Voltage Regulator IC shown in fig.8.It is used to maintain a constant 5V DC output regardless of variations in input voltage. Since the Li-ion battery voltage may fluctuate between 3.7V and 4.2V, the regulator ensures stable voltage supply to the STM32

microcontroller, GSM module, and ultrasonic circuit. Stable voltage regulation improves system reliability and prevents malfunction due to voltage drops or spikes.

Fig. 8. 7805 Voltage Regulator IC

[vii] Push Button: The push button is used to control system operations shown in fig.9. such as starting or stopping the winding process. It provides manual control and allows the user to interact with the system easily.

Fig. 9. Push Button

[viii] Charging Module: The Charging Module such as TP4056) plays a crucial role in maintaining battery safety and longevity, as shown in Fig. 10. It provides constant current–constant voltage (CC–CV) charging specifically designed for Li-ion batteries. The module includes protection features such as overcharge protection, over-discharge protection, and short-circuit protection. This ensures safe charging operation and prevents battery damage. It also allows convenient USB charging, making the device user-friendly and portable. the charging module is directly connected to the Li-ion battery and power supply section for efficient energy management.

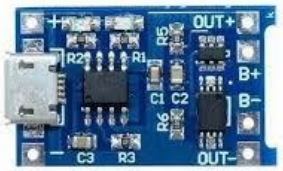

Fig. 10. Power Module

Working of Proposed System

The working of the proposed Animal Deterrent System for Domestic Areas is based on ultrasonic sound generation combined with communication and control mechanisms to ensure personal safety. The system operates in a simple, efficient, and user-friendly manner. Initially, the device remains in standby mode to conserve battery power. The Li-ion battery supplies power to the circuit through the charging module and 7805 voltage regulator, ensuring a stable 5V supply to all components. The STM32 microcontroller continuously monitors the input section while maintaining low power consumption. When the user encounters a stray dog disturbance during walking, jogging, or bike travel, the panic push button is pressed. This input signal is immediately detected by the microcontroller. Upon activation, the controller generates control signals for the ultrasonic generator circuit. The ultrasonic generator then produces high-frequency sound waves in the range of 20–40 kHz. These ultrasonic waves are transmitted through the ultrasonic transducer. The high-frequency sound is inaudible to humans but creates discomfort for dogs, causing them to retreat without any physical harm, ensuring a humane and safe deterrent mechanism. Simultaneously, the microcontroller activates the GSM/GPRS module (SIM800L or SIM900A) through serial communication. An alert message is sent to a predefined mobile number indicating that the system has been triggered. To enhance reliability, the STM32 utilizes an interrupt-driven architecture, ensuring the panic signal is processed with zero latency, even if the system is in a low-power sleep state. The GSM module is programmed to verify network handshake protocols before dispatching the

SMS, preventing data loss in areas with weak cellular coverage.T he system includes a high-intensity LED flasher that pulses in sync with the ultrasonic bursts, providing a visual deterrent that disorients the animal while signaling the user's location to bystanders. The voltage regulator ensures stable system operation, while the charging module maintains battery safety. All components function together in a coordinated manner to provide quick response and reliable protection.

Implementation of The Proposed System

The implementation of the proposed Animal Deterrent System for Domestic Areas involves the integration of hardware and embedded control techniques to ensure effective and portable operation shown in the fig.11. The system is built around the STM32 microcontroller, which acts as the central processing unit. All input and output modules are interfaced with the microcontroller according to the designed circuit diagram. Initially, the power supply section is developed using a Li-ion rechargeable battery, charging module, and 7805 voltage regulator to provide stable 5V output. Proper voltage regulation is verified before connecting sensitive components. The ultrasonic generator circuit is designed to produce high-frequency sound waves in the range of 20–40 kHz. A driver transistor or relay module is used to amplify the signal and drive the ultrasonic transducer effectively. The push button is connected as a manual trigger input. When pressed, it sends a signal to the microcontroller, which activates the ultrasonic generator instantly. Simultaneously, the GSM module (SIM800L/SIM900A) is interfaced using serial communication to send an alert message to the registered mobile number. If required, GPS data can also be transmitted. All components are mounted on a general-purpose PCB and securely connected using jumper wires during testing. After successful testing and debugging, the circuit is enclosed inside a PVC pipe body with proper insulation and protection.

Fig. 11. Implemention of Proposed System

VI. RESULTS AND DISCUSSIONS

The proposed Animal Deterrent System was successfully implemented and tested under real-time domestic conditions. The ultrasonic generator produced high-frequency sound in the range of 20–40 kHz, effectively disturbing stray dogs without causing harm. During testing, the device responded instantly when the panic button was pressed, and dogs moved away within a short distance. The GSM module successfully transmitted alert messages to the registered mobile number. The power supply system provided stable voltage throughout operation. Overall, the system demonstrated reliable performance, quick response, portability, and effective dog repellent capability in street and residential environments.

VII. CONCLUSIONS

The Animal Deterrent System for Domestic Areas has been successfully designed and implemented to address stray dog disturbances during walking, jogging, and bike travel. The system effectively utilizes ultrasonic sound waves to repel dogs in a safe and humane manner. Integration of the STM32 microcontroller, GSM module, and regulated power supply ensures reliable operation and real-time alert capability. The portable design using a PVC enclosure enhances user convenience and mobility. Overall, the proposed system provides a low-cost, efficient, and user-friendly solution for improving personal safety in domestic and street environment.

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