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Elephant Deterrent Device

6^{th} Semester

IoT and Applications

(UE21EE342BC6)

PES University

Name	SRN	Contribution Level	Contribution
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1 Introduction

The Elephant Deterrent Device is designed to assist forest officials in safely repelling elephants during their patrols. This wearable device leverages loud sounds and bright lights to scare away elephants, thereby enhancing the safety of both officials and wildlife. Key objectives include integrating a GSM module that sends real-time alerts to the cloud or a designated operator upon activation. By pressing a button, officials can trigger the deterrence mechanisms, which simultaneously send the GPS location and a picture of the elephant to the nearest control station. This ensures that the control station receives timely and accurate information, allowing for prompt and effective response to elephant encounters.

1.1 Problem Statement

Forest officials in India face significant risks while patrolling areas inhabited by elephants. The lack of effective deterrents and safety measures has resulted in numerous fatal encounters. This not only endangers the lives of these officials but also hampers conservation efforts and forest management operations. The issue is exacerbated by the elephants' expanding range into human-dominated landscapes, driven by deforestation and habitat encroachment. According to the data presented in the Rajya Sabha by the Indian government's Ministry of Environment, Forest and Climate Change, From 2020-21 to 2023-24, a total of 1,701 humans were killed by elephants across 16 states in India [1] .

1.2 Available Solutions

1. **Traditional Methods:**
   - (a) **Fencing and Trenches:** Physical barriers such as electric fences and trenches are designed to prevent elephants from entering human settlements. However, elephants often find ways to breach these barriers, and maintenance can be challenging and costly. Refer Figure:**??** [2][3].
   - (b) **Firecrackers and Drums:** These are used to scare away elephants but are often temporary solutions and can cause the animals to become habituated, reducing their effectiveness over time. Refer Figure:**??**.

Figure 1.1: Images of elephant with fence [2][3]

Figure 1.2: Images of firecrackers used on elephants [4]

2. **Technological Solutions:**

   (a) **Electric Fences:** Electrified barriers can deter elephants effectively but pose risks to other wildlife and humans. They also require significant maintenance and are prone to power failures.

(b) **Mobile Applications:** Apps like 'Gaj Yatra' allow locals to report elephant sightings, helping to alert forest officials in real time. However, these apps rely on user participation and timely updates.

(c) **Wearable Deterrent Devices:** Devices like the proposed Elephant Deterrent Device, which emit loud sounds and bright lights, scare elephants away, and send alerts to control stations. These devices can provide real-time data and enhance the safety of forest officials.

1.3 Impact on Society

1. **Psychological Impact:** The loss of life among forest officials creates a sense of fear and insecurity within the community. The psychological trauma affects the morale of other officials and their families, potentially leading to decreased efficiency and higher turnover rates.

2. **Human-Wildlife Conflict:** Increased hostility between humans and elephants can lead to more aggressive encounters, further endangering both parties. This can result in a vicious cycle of retaliation and violence against elephants.

3. **Cultural Loss:** Elephants hold cultural significance in India, symbolizing various religious and cultural values. Increasing conflicts threaten to alter the perception of these majestic animals from symbols of heritage to sources of danger, eroding cultural traditions and community bonds.

Other concerns also include,

1. **Conservation Efforts:** The death of experienced forest officials hampers conservation efforts. The loss of skilled personnel leads to gaps in knowledge transfer and disrupts ongoing conservation projects, potentially causing setbacks in wildlife management and protection strategies.

2. **Ecological Balance:** Human interventions aimed at reducing conflicts, such as the relocation of elephants, can disrupt the ecological balance. Elephants play a crucial role in their ecosystems as mega-herbivores, and their removal can have cascading effects on vegetation and other wildlife.

3. **Policy and Legislation:** There is an urgent need for revised policies and legislation that focus on better protection for forest officials and sustainable conflict mitigation strategies. Enhanced training programs, better equipment, and more robust support systems are necessary to address the root causes of human-elephant conflicts effectively.

1.4 Impact on Economy

The deaths of forest officials due to elephant attacks have several economic repercussions:

1. **Compensation Costs:** The government incurs significant expenses in compensating the families of deceased officials. According to the Wildlife Protection Society of India, compensation payments can amount to several lakhs per victim.

2. **Medical and Rescue Costs:** Injured officials require medical treatment and rehabilitation, adding to the financial burden. Emergency rescue operations and long-term care for injured personnel further strain resources.

3. **Operational Delays:** Frequent attacks disrupt forest management activities, affecting timber production, anti-poaching efforts, and tourism. The disruption of these activities can lead to economic losses for local communities and the broader economy.

For further exploration into the underlying issue refer to the document **"EVALUATION STUDY ON HUMAN ELEPHANT CONFLICT-THE MITIGATION METHODS EMPLOYED AND ITS IMPACT ON CONFLICT RESOLUTION"** by **KARNATAKA EVALUATION AUTHORITY, DEPARTMENT OF PLANNING, PROGRAMME MONITORING AND STATISTICS, GOVERNMENT OF KARNATAKA** [5]. This document gives a complete report on the work done to reduce conflict between elephants and humans. This report also provides info about the impact of the elephant attacks on farmers and the compensations provided.

2 Technical Details

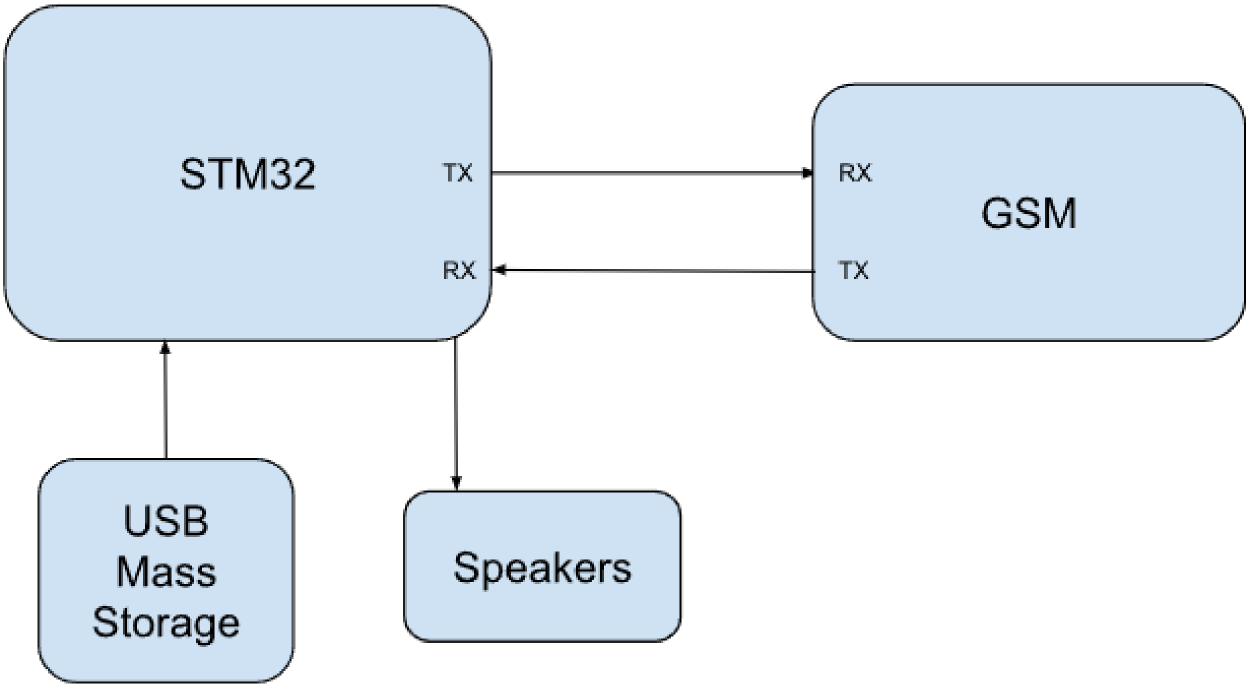

Figure 2.1: Block diagram of hardware

1. **Playing Audio through STM32:**

   (a) Objective: The goal is to enable the STM32 microcontroller to play audio from a WAV file stored on a USB drive through a speaker connected via the audio jack.

   (b) USB Host Functionality: USB Host feature available on STM32 to detect the insertion of a USB drive.

   (c) WAV File Parsing and Decoding: Develop firmware or use existing libraries to parse and decode the WAV file. Extract audio samples and handle audio playback functionality.

   (d) Software Development: Write firmware code to manage USB communication, file system access, audio decoding, and audio playback control. Implement necessary drivers and libraries for USB and audio peripherals.

   (e) File Format Analysis: The WAV (Waveform Audio File Format) is a standard format for storing audio data. Begin by analyzing the WAV file format, including header structure, data chunk layout, and audio sample encoding (e.g., PCM, ADPCM).

(f) Header Parsing: Develop firmware code to parse the WAV file header. Extract essential information such as audio format, sample rate, bit depth, and audio duration from the header section. Data Chunk Processing: Navigate through the WAV file's data chunks, especially the 'data' chunk containing audio samples. Implement algorithms to read and interpret audio samples based on the specified format and encoding.

(g) Audio Decoding: Depending on the audio encoding (e.g., PCM), develop decoding routines to convert binary audio samples into analog values suitable for playback. Apply appropriate decoding techniques such as amplitude scaling, data type conversion, and sample rate adjustment.

(h) Buffering and Playback: Create buffers to store decoded audio samples efficiently. Implement playback mechanisms using DMA (Direct Memory Access) or interrupt-driven approaches to stream audio data to the audio codec or DAC for playback.

(i) Error Handling: Include error handling mechanisms to manage file format errors, unsupported audio features, or decoding failures. Implement strategies such as error flags, retry mechanisms, and fallback options for robust audio playback.

2. Sending Message through SIM800C:

(a) Objective: Establish communication with a remote operating center by sending SMS messages using the SIM800C GSM module. SIM800C Interface: Connect the SIM800C GSM module to the STM32 microcontroller using UART communication.

(b) AT Commands Protocol: Utilize the AT commands protocol to control SIM800C functionalities. This includes sending AT commands to initialize the module, configure SMS settings, and send SMS messages.

(c) GSM Network Configuration: Configure the SIM800C module with appropriate GSM network settings such as APN (Access Point Name), SIM card details, and network authentication parameters.

(d) Firmware Development: Develop firmware code to handle SMS message composition, including recipient number, message content, and sending commands. Implement error checking and retry mechanisms for reliable message delivery.

(e) UART Communication: Set up UART communication between STM32 and SIM800C, manage data transmission, and handle responses from the GSM module.

(f) USB Host Mode: Configure the STM32 microcontroller to operate in USB Host mode to interface with USB Mass Storage Devices (USB MSDs) like USB flash drives.

(g) USB Library Integration: Utilize USB libraries such as STM32Cube USB or USBHost library to handle USB communications and protocol implementation.

(h) Device Enumeration: Implement device enumeration routines to detect and identify connected USB MSDs. This involves sending and processing USB control requests to gather device information.

(i) File System Access: Develop code to access the file system of the USB MSD. Implement functionalities to navigate directories, open/read files, and retrieve file attributes (e.g., size, type).

(j) Data Transfer: Utilize USB Bulk Transfer mechanisms to transfer data between the STM32 microcontroller and the USB MSD. Implement read/write operations for file data handling.

(k) Error Handling and Recovery: Include error detection and recovery mechanisms for USB communication errors, device disconnections, or file system issues. Implement error codes, status flags, and retry strategies to ensure reliable USB communication and data access.

3. **Flashing Lights on STM32:**

(a) Objective: Create a visual indicator on the STM32 microcontroller by flashing lights in an alternate pattern. GPIO Pin Control: Utilize GPIO pins on the STM32 microcontroller to control LEDs or other light sources for visual indication.

(b) Software Algorithm: Implement a software algorithm to toggle GPIO pins in an alternative pattern to create the flashing effect. This can be achieved using a timer-based approach or software delays.

(c) Timer Interrupts or Delays: Use timer interrupts or software delays to control the timing and frequency of LED toggling. Timer interrupts provide more accurate timing control, while software delays offer a simpler implementation.

(d) Power Considerations: Consider power consumption and hardware limitations when designing the flashing algorithm. Optimize the code to minimize energy consumption, especially in battery-powered applications.

(e) Integration: Integrate the flashing lights functionality with other parts of the project logic as needed. This may involve synchronization with other tasks or events in the firmware.

3 Block Diagram

3.1 Software Layer Abstraction

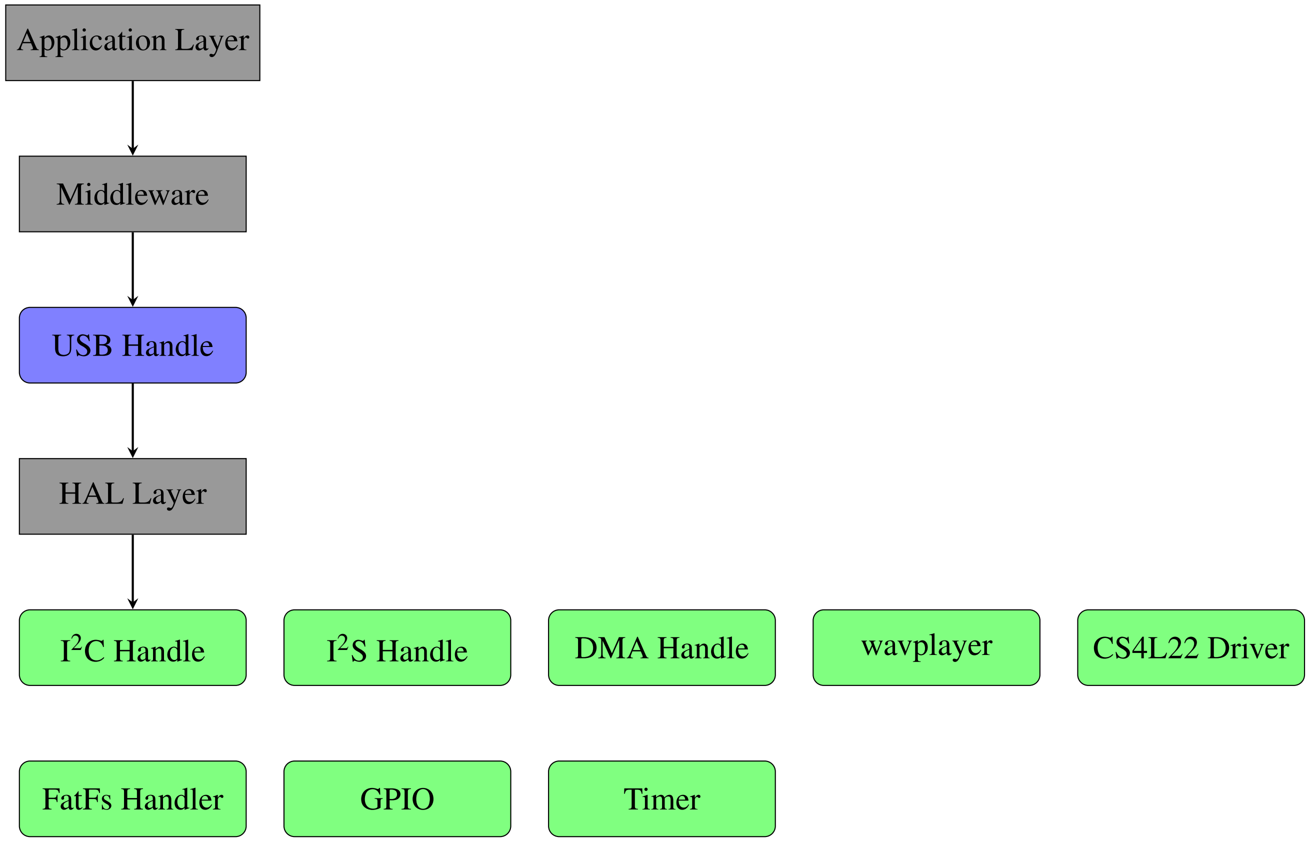

Figure 3.1: Code implementation structure

3.2 Flow of Logic

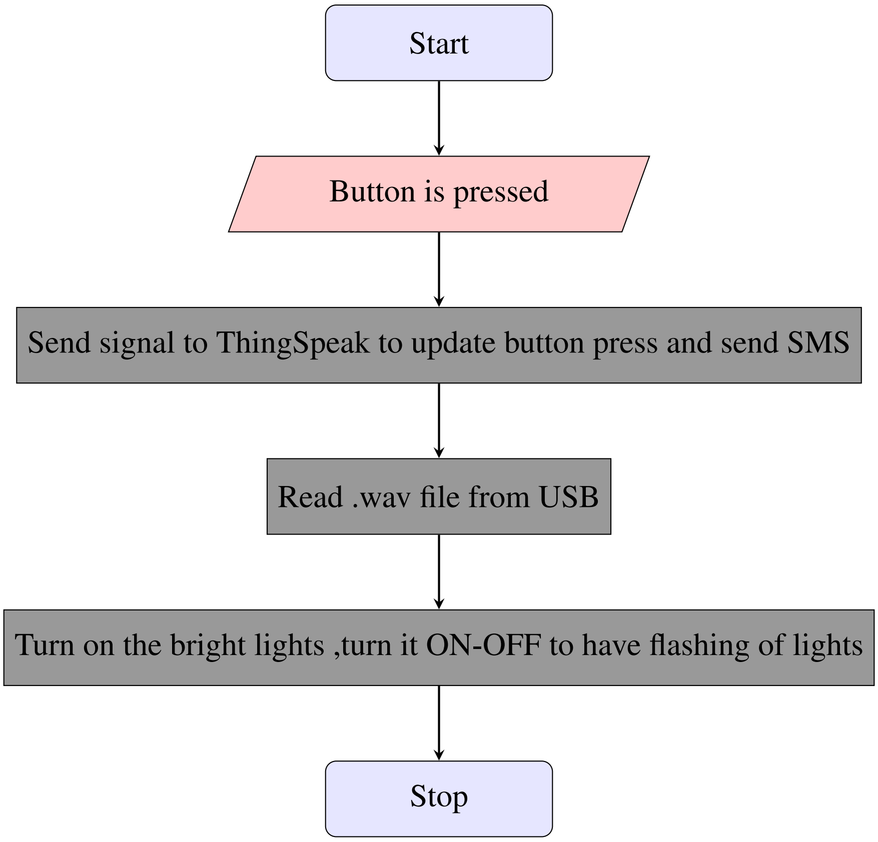

Figure 3.2: Flow of code

A flag will be polled through a while loop. The while loop will have a code to put the STM32 in to sleep mode at the end. When the button is pressed an interrupt is called which will set a flag indicating a button is pressed and wakes-up the micro-controller. When it wakes up, the while condition is check i.e checking if the flag is set. If it is set the code starts the above flow of code. First it alerts the operator about the button press primarily through ThingSpeak and then through SMS.

4 GSM Setup

1. SIM800C is a widely used GSM Module with a serial interface modem which runs in between 3.4V-4.4V Voltage level.
2. SIM800C is a Quad-band GSM/GPRS Module that is used in embedded applications where remote data transfer is required.
3. SIM800C works on 850/900/1800/1900MHz. It can also receive & transmit Voice Call, and SMS with low power consumption. The module is controlled by using AT commands.
4. It supports one SIM card interface and has UART (TX & RX) pins along with one RS232 Serial Protocol that can be used to interface with different microcontrollers in embedded applications

Steps to initialize ThingsSpeak Interaction :

Sl. No	AT Command	Function	Response
1	AT+CGATT?	GPRS attachment	1
2	AT+CIPMUX=?	IP connection	1
3	AT+CSTT=?	SET(apn,username,password)	OK
4	AT+CIICR=?	Set up wireless connection	OK
5	AT+CIFSR=?	Get local IP address	
6	AT+CIPSTART	Startup TCP or UDP connection	AT+CIPSTART=,< mode>,,
7	AT+CIPSEND	Send Data Through TCP or UDP Connection	OK

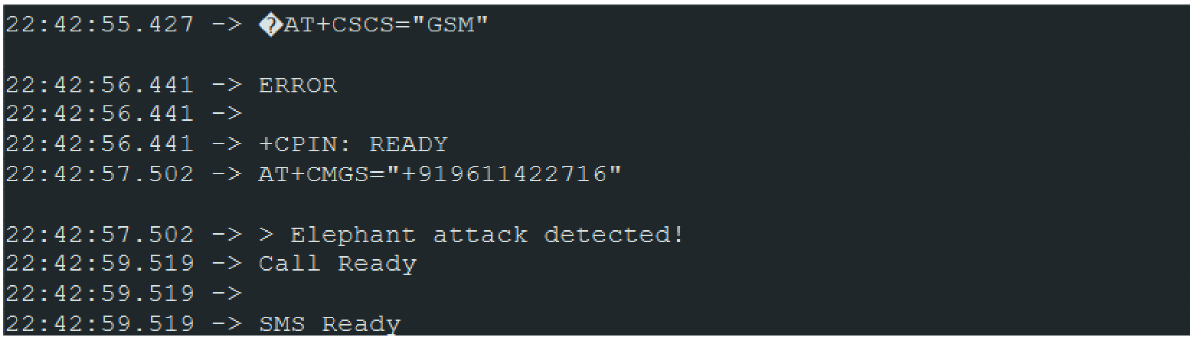

Figure 4.1: Serial Monitor response to SMS

Steps to send SMS:

Sl. No	AT Command	Function	Response
1	AT	Hand-Shake	OK
2	AT+CSQ	Check signal quality	(0,0) to (0,31)
3	AT+CREG?	Check registered network	0,2
4	ATI	Returns the module name and revision	SIM800 R14.18
5	AT+COPS?	Checks which network you are connected to.	+COPS:0
6	AT+COPS=?	Returns the list of operators present in the network	(1,"Airtel","AIRTEL","40445"),(3,"Hutch-Kamataka","HUTCH","40486"),(0-4),(0-2)

Refer document **"SIM800 Series_AT Command Manual_V1.12"** from SIMCom official website [6]. You will have to create an account and then you will be able to download the above-mentioned robot.

5 Progress

1. We have successfully played audio on a headphone using STM32.
2. We have partially implemented the GSM whose output have are shown in Figure:**??**. We were able to successfully connect the GSM to TCP/UDP, but were not able to send the values.
3. The code for the audio on the STM32 and for GSM are completed.
4. When the GSM successfully gets connected ti ThingSpeak we will merge both the implementations.

5.1 Future Work

1. We have to send AT commands from the STM32 to the GSM module.
2. Decide upon the driver and setup for implementing the lighting system.
3. Refine the code on the STM32 to make it more professionally sound and structured optimally to meet power requirements.
4. To implement power management for the device.

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