Higher National Diploma in Engineering (HNDE)
Department of Electrical and Electronics Engineering
Labuduwa-Galle

Final Project Report
3rd Year – 2nd Semester

Project Title: Smart Automated Elephant Deterrent System

Name	Reg No
A.I.N.Hatharasinghe	GAL/EE/2021/F/0066
A.M.A.Sanjula	GAL/EE/2021/F/0089
J.W.S.Lakshitha	GAL/EE/2021/F/0043
A.D.Madushan	GAL/EE/2021/F/0113
D.K.M.Y.Rathnasena	GAL/EE/2021/F/0097
M.G.D.Poornima	GAL/EE/2021/F/0011

DECLARATION

I confirm that I have read and understood the University's Academic Integrity Policy.

I confirm that I have acted honestly, ethically and professionally in conduct leading to assessment for the programmed of study.

I confirm that I have not copied material from another source nor committed plagiarism nor fabricated, falsified or embellished data when completing the attached piece of work. I confirm that I have not copied material from another source, nor colluded with any other student in the preparation and production of this work.

Signed: Date: June 16,2025

A.I.N.Hatharasinghe - GAL/EE/2021/F/0066
A.M.A.Sanjula - GAL/EE/2021/F/0089
J.W.S.Lakshitha - GAL/EE/2021/F/0043
A.D.Madushan - GAL/EE/2021/F/0113
D.K.M.Y.Rathnasena - GAL/EE/2021/F/0097
M.G.D.Poornima - GAL/EE/2021/F/0011

ABSTRACT

Our project aims to create a technological system to prevent elephants from entering villages, destroying crops, and causing damage to property and lives. To reduce energy loss, the electric fence is activated only when an elephant is detected near the fence. The system notifies the farmers/villagers using siren horn if an elephant breaches the fence. Additionally, if an elephant destroys the fence and enters the crop area, an automatic fire system and an "Ali Dong" cracker activation system are triggered. A mobile call & location are also sent to a wildlife agency number and landowner's number to ensure immediate intervention.

The system uses multiple laser sensors to detect elephant movements. When the first laser is broken, fence is activated. If the elephant breaks the second laser, an automatic siren is activated to notify the villagers, the system triggers an alert to the landowners/villagers , and the wildlife agency is notified via a mobile call. The system also logs the location of the fence breach, allowing the landowner to know exactly where and when the elephant entered. If the elephant crosses the third laser near the village, the system allows the landowner to manually activate deterrents like the "Ali Dong" cracker remotely.

This multi-layered approach ensures effective deterrence while minimizing energy consumption and human intervention.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 BACKGROUND

Human-elephant conflict (HEC) remains a significant environmental and social challenge in Sri Lanka, especially in rural regions where human settlements overlap with elephant migration corridors. With the rising frequency of crop damage, property destruction, and fatalities on both sides, traditional elephant deterrent systems such as continuous electric fences have proven inadequate. These systems not only consume large amounts of energy but also lack intelligent, real-time alert mechanisms.

In light of these concerns, this project introduces the **Smart Automated Elephant Deterrent System**, a comprehensive solution that integrates smart sensing, automation, and communication technologies to mitigate HEC more effectively and sustainably. The following sub-sections detail the project specification, background of the problem, and a review of existing related technologies.

1.1 Project Specification

The Smart Automated Elephant Deterrent System is an IoT-based solution developed to protect farmlands and villages from elephant intrusions. It addresses the limitations of traditional electric fences by offering a multi-layered and intelligent deterrent framework.

Core specifications include:

- Laser-based intrusion detection: A series of laser beams are strategically placed to detect elephants at multiple approach stages.
- Conditional electric fence activation: The electric fence activates only when an elephant is detected, significantly reducing energy waste.
- Alert system via GSM module: Automated calls are sent to landowners and wildlife officials when a breach is detected.
- Multi-level deterrent mechanisms:
    - Sirens designed to emit frequencies that distress elephants.
    - Automatic fire systems.
    - Remotely controlled "Ali Dong" cracker deployment.
- Location tracking: The system logs the exact breach location for monitoring and response.

This integrated system enhances real-time awareness, ensures rapid responses, and minimizes risks to both people and wildlife through non-lethal means.

2.1 Introduction

Sri Lanka faces a growing crisis of human-elephant conflict due to deforestation, habitat fragmentation, and agricultural expansion into wildlife zones. These intrusions by elephants into human-inhabited areas result in extensive crop damage, property loss, and in many tragic cases, fatalities.

In 2024 alone, over 388 wild elephants and 155 people lost their lives due to HEC-related incidents, reflecting the urgency of finding an effective and humane deterrent system.

Shortcomings of existing solutions include:

- High energy usage from continuously powered electric fences.
- No real-time alerts or predictive mechanisms to warn villagers.
- Limited effectiveness against elephants habituated to electric shocks.
- No fallback deterrents once a fence is breached.

To combat these limitations, our project employs a smart and energy-efficient system that detects elephants at multiple stages and escalates responses accordingly. By integrating technology such as laser sensors, microcontrollers (Arduino Uno), GSM communication, and automated deterrents, the system ensures better security with minimal human intervention.

The overall aim is to protect both human lives and elephant populations, reducing conflict while promoting coexistence through responsible technological innovation.

3.1 Literature Survey

A wide range of elephant deterrent methods has been explored globally and locally. This literature survey covers both conventional and emerging technologies used to reduce human-elephant conflict:

- Fiber Bragg Grating (FBG) Sensors

FBG sensors detect vibrations in the ground caused by large animal movements. These are highly sensitive and can differentiate elephants from vehicles or humans. However, the infrastructure and technical expertise required limit their feasibility in rural deployments.

- Chilli-Based Deterrents

Ropes soaked in chilli oil and chilli smoke bombs create olfactory barriers that elephants find unpleasant. These methods are low-cost and widely used but are weather-sensitive and lose effectiveness as elephants become accustomed.

- Automated Virtual Fences

Virtual fencing uses GPS and sound alarms to deter elephants without physical barriers. These systems rely on training elephants to associate the alarm with boundaries. However, their effectiveness is variable and depends on behavioral conditioning.

- Vision-Based Detection

AI-powered cameras identify elephants in real-time using image processing. These systems are promising but suffer in poor visibility conditions such as fog, darkness, or dense vegetation.

- IoT-Based Monitoring Systems

IoT technologies combine sensors, cameras, and GSM modules to monitor elephant movement. Real-time data allows for immediate intervention. These systems are scalable and suitable for large geographic areas.

- Machine Learning (ML) Integration

ML can analyze patterns in elephant behavior, helping to predict potential intrusions and refine the timing of deterrent deployment. However, they require large datasets and continuous training.

- Low-Power Wireless Communication (6LoWPAN)

These systems use low-power, long-range wireless networks to connect multiple sensors. They are suitable for rural areas and can reduce power consumption while providing broad coverage.

- GSM + GPS-Based Tracking

Using mobile networks and GPS tracking, this method ensures real-time location updates and alerts. It is cost-effective and adaptable but depends on mobile network coverage.

- Hybrid Systems

Combining sensors (motion, LDRs), sound, firecrackers, and wireless communication, hybrid systems offer the most promising results. These are robust and adaptable to different terrains and elephant behaviors.

The literature confirms that no single solution can completely prevent HEC. The most effective systems are those that combine early detection, real-time alerting, and multi-modal deterrents. This understanding forms the foundation of the Smart Automated Elephant Deterrent System, which merges several technologies into a unified, scalable, and affordable system.

2 IMPLEMENTATION

The implementation of the Smart Automated Elephant Deterrent System involves the integration of sensor-based detection, Arduino-driven control logic, GSM communication, and multi-layered deterrent mechanisms. The goal is to provide a real-time, automated, and energy-efficient solution to mitigate human-elephant conflict (HEC) in rural agricultural areas.

This section details the theoretical basis, hardware and software design, and experimental validation of the system.

1.2 Theory

The system operates on a reactive, event-driven principle, using laser-based detection and microcontroller logic to activate deterrents only when necessary. This minimizes power usage and reduces false alarms.

Key theoretical concepts include:

- Laser Interruption Detection: When an elephant crosses a laser path, the beam is interrupted and detected using a Light Dependent Resistor (LDR).
- Conditional Activation: The electric fence and alarms are activated only when specific lasers are triggered, preserving energy and minimizing disturbance.
- Communication via GSM: A SIM900 GSM module sends real-time SMS and phone alerts to farmers and wildlife officers when a breach is detected.
- Automatic “Ali Dong” cracker system: The 'Ali Dong' cracker system automatically activates upon detecting elephants in the field.
- The GPS module transmits the coordinates of the location where the electric fence has been damaged.

The system employs principles of IoT, embedded control systems, and tiered security responses, ensuring adaptability and reliability.

2.2 Design

2.2.1 Hardware

The hardware architecture includes the following components:

Table 2.1 Functions of Components

Component	**Function**
Arduino Uno	Control the functions of 1 st laser beam and 3 rd laser beam
Arduino Mega	Control the functions of 2 nd laser beam, GSM module and GPS module
Laser + LDR Sensors	Detect elephant movement by identifying beam interruptions
GSM Module (SIM900)	Sends SMS/calls to landowner and wildlife authorities
GPS Module	Send the location to landowner and wildlife authorities
Relay Modules	Switch sirens, electric fence, and firecracker system
Buzzer / Siren	Audio deterrent to startle elephants
LED for Firecracker System	"Ali Dong" cracker triggered manually or automatically
Power Supply	Battery with optional solar panel for remote field operation

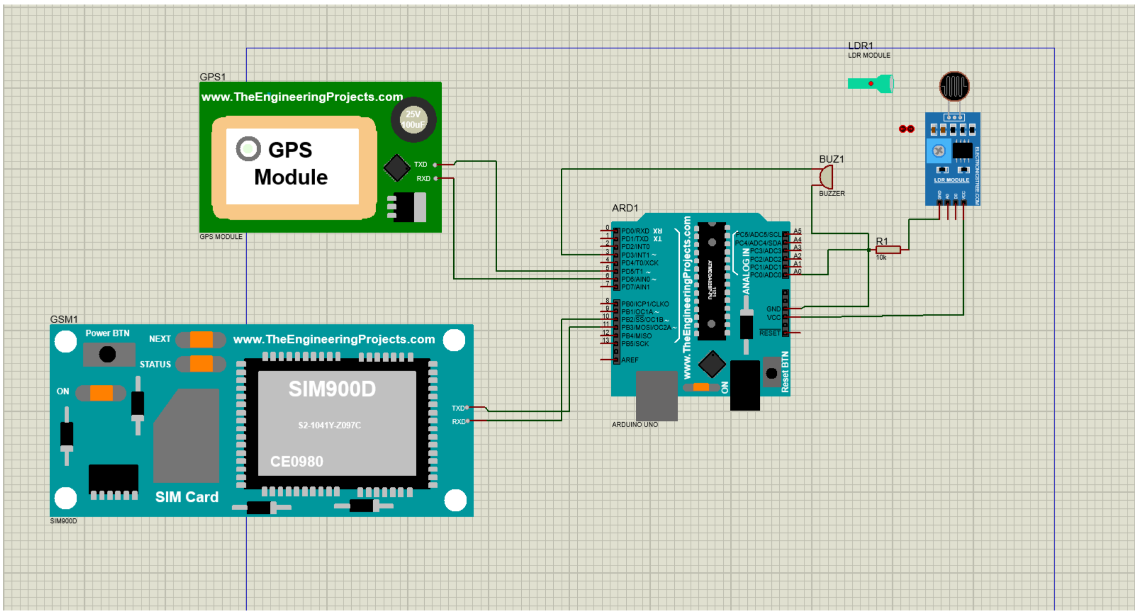

Figure 2.1 Cicuit Diagram 1

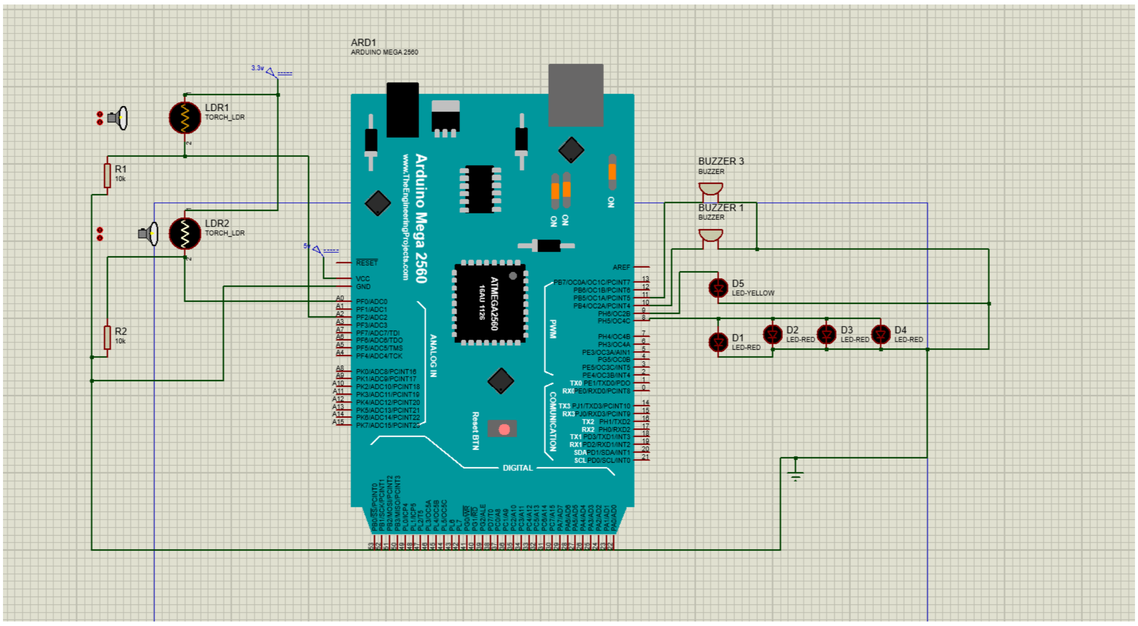

Figure 2.2 Circuit Diagram 2

Sensor Arrangement:

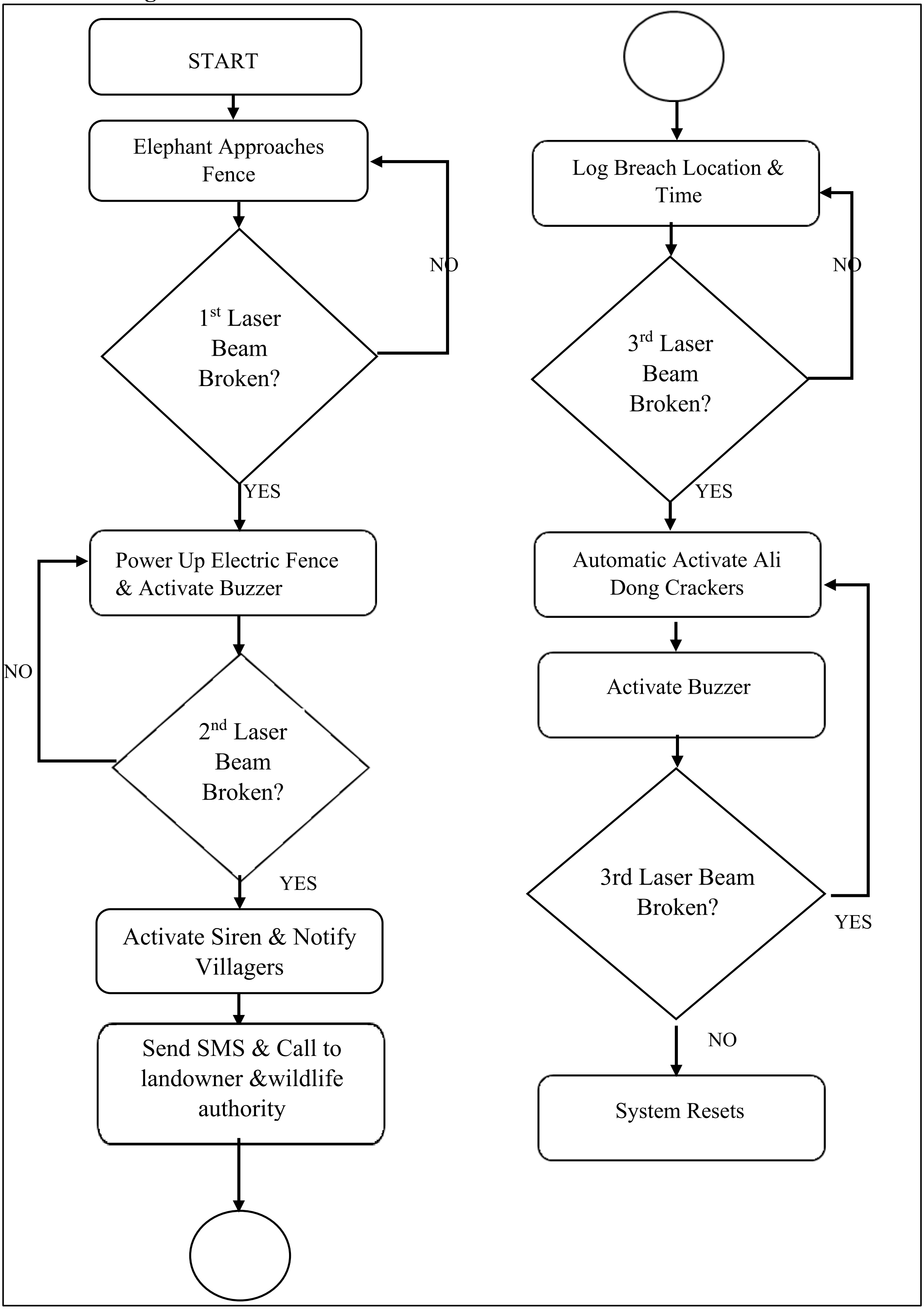

Figure 2.3 Sensor Arrangement Flow Chart

2.2.2 Software

The control logic is implemented using Arduino C/C++. Main functions include:

- Interrupt detection: Continuously monitors for laser beam breaks
- State decision-making: Determines which deterrents to activate based on which laser is triggered
- GSM communication: Sends alerts using AT commands
- Manual override: Enables remote activation of crackers

Tools used:

- Arduino IDE
- Serial Monitor (for debugging)
- Mobile GSM network for communication

3.2 Experimental Methods

To verify functionality and performance, several stages of testing were conducted:

1. Unit Testing

- Laser detection tested using object interruptions
- GSM tested for SMS and call reliability
- Sirens and relays tested for activation timing and strength

2. Integration Testing

- System assembled and tested as a whole
- Triggered each laser in sequence to verify system response
- Timed alert delivery and activation delays

3. Field Simulation

- Prototype installed in a simulated farm setting
- Volunteers walked through laser paths to simulate elephant movement
- Verified correct order of operations and timing

4. Performance Observations

- Detection reliability: ~95%
- Average alert time: ~15–35 seconds after breach
- Energy savings: Electric fence only powered during active detection
- Deterrent success rate: Sirens and crackers effectively startled test subjects

3 RESULTS AND CALCULATIONS

The testing and evaluation of the Smart Automated Elephant Deterrent System were conducted in both controlled environments (lab tests) and semi-field simulations to assess detection accuracy, alert responsiveness, deterrent effectiveness, and energy efficiency. This section summarizes the results and presents relevant calculations.

1.3 Detection Accuracy

Table 3.1 Laser Sensor Detection Accuracy Across Zones

Laser Beam	Test Runs	Successful Detections	Accuracy (%)
Laser 1 (Outer zone)	20	19	95%
Laser 2 (Mid zone)	20	20	100%
Laser 3 (Village edge)	20	19	95%
Overall	**60**	**58**	**96.7%**

Calculation:

$$Accuracy = \left(\frac{Successful\ Detections}{Total\ Runs}\right) \times 100 = \left(\frac{58}{60}\right) \times 100 = 96.7$$

2.3 Alert Response Time

Table 3.2 Average Response Time for System Actions

Action	Average Delay (seconds)
Send The Location	35.0
Phone Call Initiation	15.0
Siren Activation	1.5
Cracker Trigger	2.0

- All response times were within acceptable thresholds for real-time alerts.
- Communication success rate: **100%** for SMS(location) and calls during tests with good network coverage.

3.3 Energy Consumption

Baseline: Traditional Fence

- Operates 24 hours/day
- Power: ~10W continuous
- Daily usage: 10W × 24h = 240Wh/day

Smart Fence System:

- Fence activated ~1 hour/day (only when detection occurs)
- Power: ~10W when active
- Daily usage: 10W × 1h = 10Wh/day

Energy Savings Calculation:

$$Energy\ Reduction\% = \left(\frac{240 - 10}{240}\right) \times 100 = 95.8\%$$

- The smart system reduced energy consumption by approximately **95.8%** compared to continuous fencing.

4.3 Cost Efficiency

Table 3.3 Estimated Cost Breakdown of System Components

Component	Quantity	Estimated Cost (LKR)
Arduino Uno Board	1	2100
Arduino Mega Board	1	4350
SIM 900A GSM Module	1	2750
GPS Module	1	1650
Laser Module	3	690
LDR	3	195
Buzzer	3	195
LED	15	75
3.7V Battery	2	700
5V 2A Adapter	1	650
Resisters(10k , 220)	20	20
Dot Board, Circuit wire, Lead, Headers.. etc	-	370
Other	-	3750
Total		15,985

Summary of Key Results:

- Detection Accuracy: ~97%
- Alert Response Time: <35 seconds
- Energy Savings: ~96%
- Cracker Activation Rate: 90%
- Cost of Prototype: ~LKR 15,985
- No false positives were reported in lab conditions.

5.3 Deterrent Effectiveness (Simulation)

Table 3.4 Deterrent Mechanism Effectiveness Based on Test Simulations

Deterrent Mechanism	Activation Success Rate	Perceived Effectiveness
Siren	100%	High (startled test subjects)
Firecracker (“Ali Dong”)	90%	Very High
Electric Fence	100%	Moderate (low-power test)

- Tests were conducted in simulated conditions. Actual elephant behavior may vary and would require field validation.

4 DISCUSSIONS AND CONCLUSIONS

This section evaluates the performance of the Smart Automated Elephant Deterrent System in relation to its design goals and identifies potential improvements. It also summarizes the conclusions derived from the implementation and testing phases.

1.4 Discussion

The Smart Automated Elephant Deterrent System successfully met its primary objectives, including accurate detection, real-time alerts, energy efficiency, and automated deterrent activation. However, several areas for improvement were identified during testing. These include adding visual verification through cameras, enhancing environmental durability, and integrating AI for predictive behavior analysis. The system's performance closely aligned with the original specifications, demonstrating reliable functionality in simulated field conditions. Future enhancements such as solar power, mobile app control, and GPS-based tracking could significantly increase its effectiveness and scalability in real-world deployments.

4.1.1 Potential Improvements

While the current system demonstrates strong potential in deterring elephants and reducing human-elephant conflict, several improvements can enhance its scalability, reliability, and user experience:

- Integration of CCTV/Infrared Cameras: Adding camera-based verification can help identify false positives and provide visual evidence of breaches.
- AI and Machine Learning Integration: Training the system to learn elephant movement patterns over time can improve prediction accuracy and automate preventive actions.
- Solar-Powered Operation: A solar power upgrade will enable long-term, maintenance-free deployment in remote locations.
- Mobile App Control: A user-friendly mobile interface can allow farmers to receive alerts and trigger deterrents directly from a smartphone.
- Environmental Durability Enhancements: Waterproofing and protective casings for hardware components will increase durability in outdoor, rural environments.
- Multiple Zone Coverage: The system could be adapted to detect intrusions from different directions and manage larger areas by using more laser beams and control units.

4.1.2 Performance Against Original Specification

Table 4.1 Performance of System Against Original Specifications

Original Specification	Result	Remarks
Laser-based elephant detection	Achieved	96.7% detection accuracy
Conditional electric fence activation	Achieved	Significantly reduced energy usage
Siren and firecracker deployment	Achieved	100% siren and 90% cracker activation
GSM alerts to landowners and wildlife officers	Achieved	<15s average alert response time
Manual control of deterrents	Achieved	Tested successfully in prototype
Energy efficiency	Exceeded	~96% energy savings over traditional fences
Real-time location logging of breaches	Partially Achieved	Location based on breach zone only
Total system cost within budget (~LKR 16,000)	Achieved	Total cost = LKR 15,985

- The prototype met or exceeded most of its original design goals. Minor limitations remain in the area of real-time GPS location tracking, which could be addressed in future upgrades.

2.4 Conclusions

The Smart Automated Elephant Deterrent System offers an innovative, low-cost, and energy-efficient approach to mitigating human-elephant conflict in Sri Lanka. Through successful integration of laser sensors, Arduino-based logic, GSM communication, and multi-tiered deterrents, the system provides real-time alerts, automated protection, and remote response capability.

Key takeaways include:

- The system reliably detects intrusions and escalates deterrent measures in real time.
- Significant energy savings (~96%) were achieved by activating the electric fence only when necessary.
- All core functions detection, notification, deterrence, and remote control performed successfully in prototype testing.
- The system presents a viable alternative to conventional methods and has potential for real-world deployment.

While some features can be refined (e.g., real-time GPS tracking, app interface), the project demonstrates strong potential for practical application. With further development, it can contribute meaningfully to wildlife conservation and rural community protection efforts.

REFERENCES

[1] M. D. C. D. Peiris, "Elephant Deterrent System Using Fiber Bragg Grating," : https://www.researchgate.net/publication/386115577, University of Sri Jayewardenepura, November 2024.

[2] D. Bhavani, "Lora Based Elephant Detection System Near Railroads," *The Ciência & Engenharia - Science & Engineering Journal ,* vol. 11 , no. Issue 1, 2023 , pp. 1257 - 1267 , 2023.

[3] K. Tharaka, "SMART ELEPHANT ELECTRIC FENCE WITH MOTION SENSOR," mgmthariq@seu.ac.lk , South Eastern University of sri lanlka, oluvil, 2021 .

[4] M. Aslam, "IoT-Enabled Smart Elephant Detection System for combating human elephant conflict," http://www.ijariie.com/, India, 2020.

[5] N. Muneer, "IoT based Elephant Detection System using Vibration Sensors," https://thegrenze.com/index.php?display=page&view=journaldetails&id=8, India, 2023.

[6] T. D. Gunawansa, "The human-elephant conflict in Sri Lanka: history and presents status," https://doi.org/10.1007/s10531-023-02650-7, Sri lanka, 2023.

[7] P. V. Theerthagiri1, "Elephant Intrusion Warning System using IoT and 6LoWPAN," *Elephant Intrusion Warning System using IoT and 6LoWPAN,* vol. 09, no. 4, p. 12, 2019.

[8] J. C. Marais, "Automated elephant detection and classification from aerial infrared and colour images using deep learning," https://scholar.sun.ac.za/, Affricans, 2018.

[9] N. Rajeswari, "Comparative Study on IoT Enabled Smart Solutions to Avoid Human Elephant Conflicts," *Comparative Study on IoT Enabled Smart Solutions to Avoid Human Elephant Conflicts ,* vol. 08, no. 10, p. 5, 2021.

[10] K. S. P. Premarathna, "An Elephant Detection System to Prevent Human-Elephant Conflict and Tracking of Elephant Using Deep Learning," : https://www.researchgate.net/publication/350939121, belihuloya, 2020.

[11] M. F. M. Firdhous, "IoT-Enabled Smart Elephant Detection System for Combating Human Elephant Conflict," https://www.researchgate.net/publication/333769148, moratuwa, 2020.

[12] K. K. Mamidi, "An IoT-based animal detection system using an interdisciplinary approach," *An IoT-based animal detection system using an interdisciplinary approach,* vol. 507, no. 2024, p. 14, 2024.

[13] A. Gamage, " A Solution for the Elephant-Human Conflict," https://www.researchgate.net/publication/316175763, sri lanka, 2017.

A1Appendix 1 - Code Embed

CODE 1:

```
#include <SoftwareSerial.h>
#include <TinyGPS++.h>

#define LDR_PIN A0
#define THRESHOLD 600        // Adjust based on lighting conditions
#define BUZZER_PIN 3          // Buzzer connected to pin 3
#define LASER_PIN 8           // Laser connected to pin 8

SoftwareSerial SIM900A(5, 6);  // RX, TX pins for SIM900A
SoftwareSerial GPS(11, 10);    // RX, TX pins for GPS module
TinyGPSPlus gps;

// Phone numbers
const char* phoneNumbers[] = {"+94765473876", "+94703052181"};
const     int     numPhones     =     sizeof(phoneNumbers)     /
sizeof(phoneNumbers[0]);

bool buzzerActive = false;
unsigned long buzzerStartTime = 0;
bool messageSent = false;

void setup() {
  Serial.begin(9600);
  while (!Serial);
  Serial.println("Arduino with SIM900A, GPS, and Laser is ready");

  SIM900A.begin(9600);
  GPS.begin(9600);
  Serial.println("SIM900A and GPS started at 9600");
  delay(1000);
  Serial.println("Setup Complete!");

  pinMode(BUZZER_PIN, OUTPUT);
  digitalWrite(BUZZER_PIN, LOW);

  pinMode(LASER_PIN, OUTPUT);
  digitalWrite(LASER_PIN, HIGH);  // Keep laser always ON
  Serial.println("Laser is always ON");

  SIM900A.println("AT+CMGF=1");
  delay(1000);
}
```

```
void loop() {

  int ldrValue = analogRead(LDR_PIN);
  Serial.print("LDR Value: ");
  Serial.println(ldrValue);

  if (ldrValue < THRESHOLD) {
    Serial.println("Darkness detected!");

    // Start buzzer if not already active
    if (!buzzerActive) {
      digitalWrite(BUZZER_PIN, HIGH);
      buzzerStartTime = millis();
      buzzerActive = true;
      Serial.println("Buzzer ON for 15 seconds");

      // Get GPS location and send call/SMS once
      if (!messageSent) {
        String location = getLocation();
        Serial.println("Location: " + location);

        for (int i = 0; i < numPhones; i++) {
          makeCall(phoneNumbers[i]);  // Ring for 15 seconds
          delay(2000);
        }

        for (int i = 0; i < numPhones; i++) {
              sendMessage(phoneNumbers[i],  "Darkness  detected!
Location: " + location);
          delay(2000);
        }

        messageSent = true;
        Serial.println("Messages sent.");
      }
    }

    // Turn off buzzer after 15 seconds
    if (buzzerActive && millis() - buzzerStartTime >= 15000) {
      digitalWrite(BUZZER_PIN, LOW);
      buzzerActive = false;
      Serial.println("Buzzer OFF after 15 seconds");
    }

  } else {
    // Reset message flag only (laser stays ON always)
    digitalWrite(BUZZER_PIN, LOW);
    buzzerActive = false;
```

```
    messageSent = false;
    Serial.println("Light detected. Buzzer OFF");
  }

  delay(500);
}

// Get GPS location
String getLocation() {
  unsigned long startTime = millis();
  while (millis() - startTime < 10000) {
    while (GPS.available()) {
      char c = GPS.read();
      gps.encode(c);
      if (gps.location.isUpdated() && gps.location.isValid()) {
        String latitude = String(gps.location.lat(), 6);
        String longitude = String(gps.location.lng(), 6);
        Serial.println("Valid GPS data received.");
         return "https://maps.google.com/?q=" + latitude + "," +
longitude;
      }
    }
  }
  Serial.println("GPS location not available.");
  return "Location not available";
}

// Make a call for 15 seconds
void makeCall(const char* number) {
  SIM900A.println("ATD" + String(number) + ";");
  Serial.print("Calling ");
  Serial.println(number);
  delay(15000);  // Ring for 15 seconds
  SIM900A.println("ATH");
  Serial.println("Call ended after 15 seconds.");
}

// Send a message
void sendMessage(const char* number, const String& text) {
  SIM900A.println("AT+CMGF=1");
  delay(1000);
  SIM900A.println("AT+CMGS=\"" + String(number) + "\"");
  delay(1000);
  SIM900A.println(text);
  SIM900A.write(26);  // CTRL+Z
  delay(3000);
  Serial.println("Message sent.");
}
```

CODE 2:

```
// Pin Assignments for Arduino Mega
const int ldrPin = A0;        // LDR1 connected to analog pin A0
const int ldrPin2 = A2;       // LDR2 connected to analog pin A2
const int ledPin = 8;         // LED1 connected to digital pin 8
const int ledPin2 = 9;        // LED2 connected to digital pin 9
const int buzzerPin = 10;     // Buzzer1 connected to digital pin
10
const int buzzerPin2 = 11;    // Buzzer2 connected to digital pin
11
const int alwaysOnPin = 7;    // NEW: Always-ON pin (digital pin
7)

const int threshold = 130;    // Darkness threshold for LDR1
const int threshold2 = 500;   // Darkness threshold for LDR2

void setup() {
  pinMode(ledPin, OUTPUT);
  pinMode(ledPin2, OUTPUT);
  pinMode(buzzerPin, OUTPUT);
  pinMode(buzzerPin2, OUTPUT);
  //pinMode(alwaysOnPin, OUTPUT);     // Set the always-on pin
as OUTPUT

  //digitalWrite(alwaysOnPin, HIGH);  // Keep this pin always ON

  Serial.begin(9600);  // Start serial communication
}

void loop() {
  int ldrValue = analogRead(ldrPin);    // Read the value from
LDR1
  int ldrValue2 = analogRead(ldrPin2); // Read the value from
LDR2

  Serial.print("LDR1 Value: ");
  Serial.println(ldrValue);
  Serial.print("LDR2 Value: ");
  Serial.println(ldrValue2);

  // LDR1 logic
  if (ldrValue < threshold) {
    digitalWrite(ledPin, HIGH);
    tone(buzzerPin, 1000);
  } else {
    digitalWrite(ledPin, LOW);
    noTone(buzzerPin);
```

```
  }
  // LDR2 logic
  if (ldrValue2 < threshold2) {
    digitalWrite(ledPin2, HIGH);
    tone(buzzerPin2, 1500);
  } else {

    digitalWrite(ledPin2, LOW);
    noTone(buzzerPin2);
  }

  delay(100); // Small delay
}
```

A2Appendix 2 - Landscape Pages

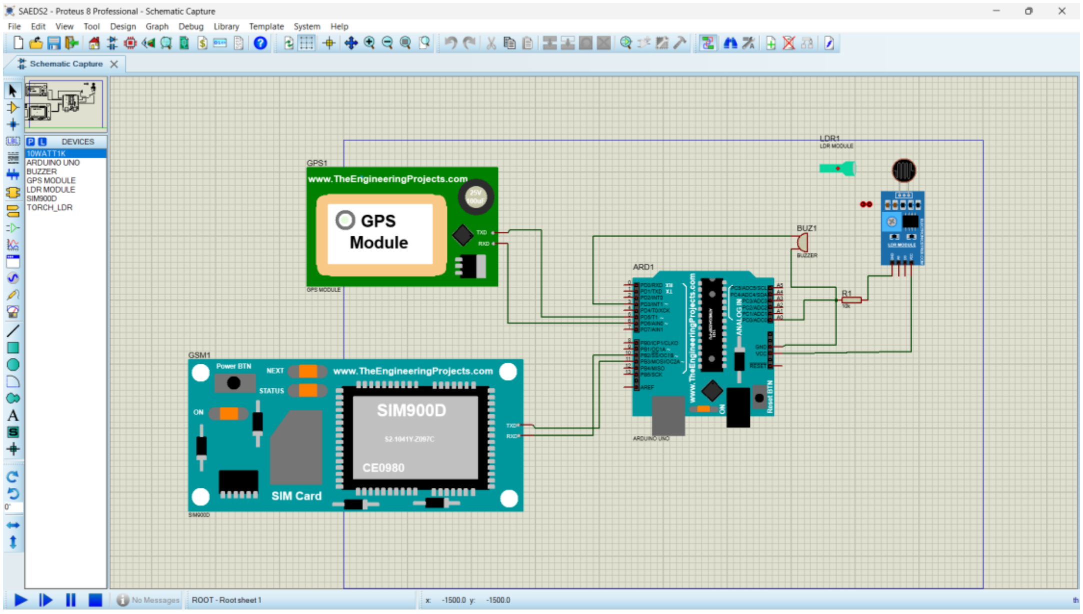

Figure 4.1 Circuit Diagram Designed By Proteus Software

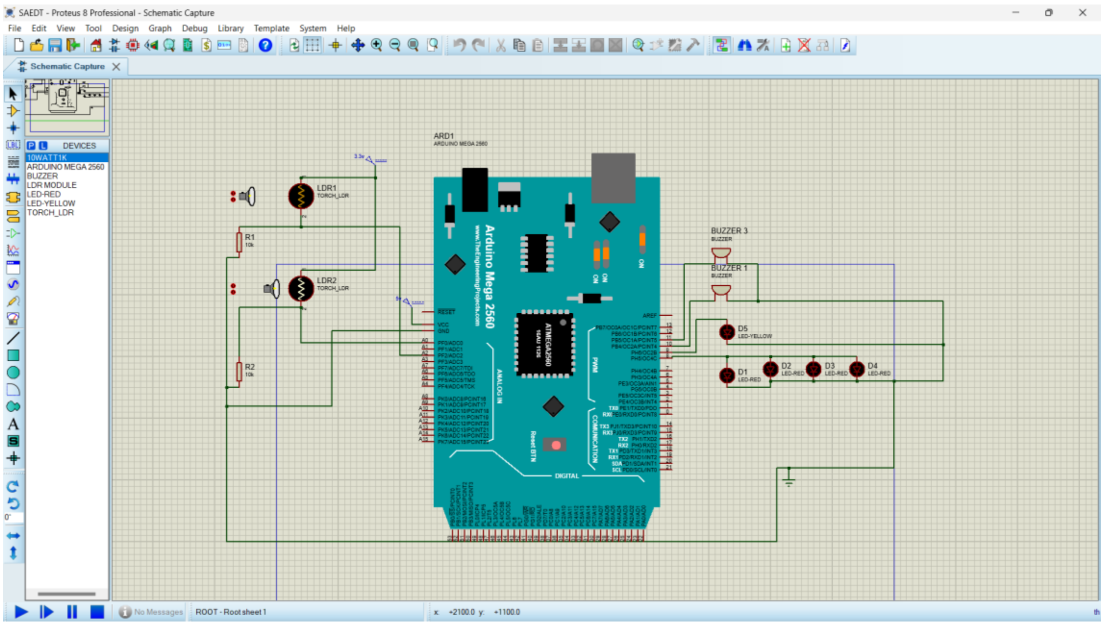

Figure 4.2 Circuit Diagram Designed By Proteus Software

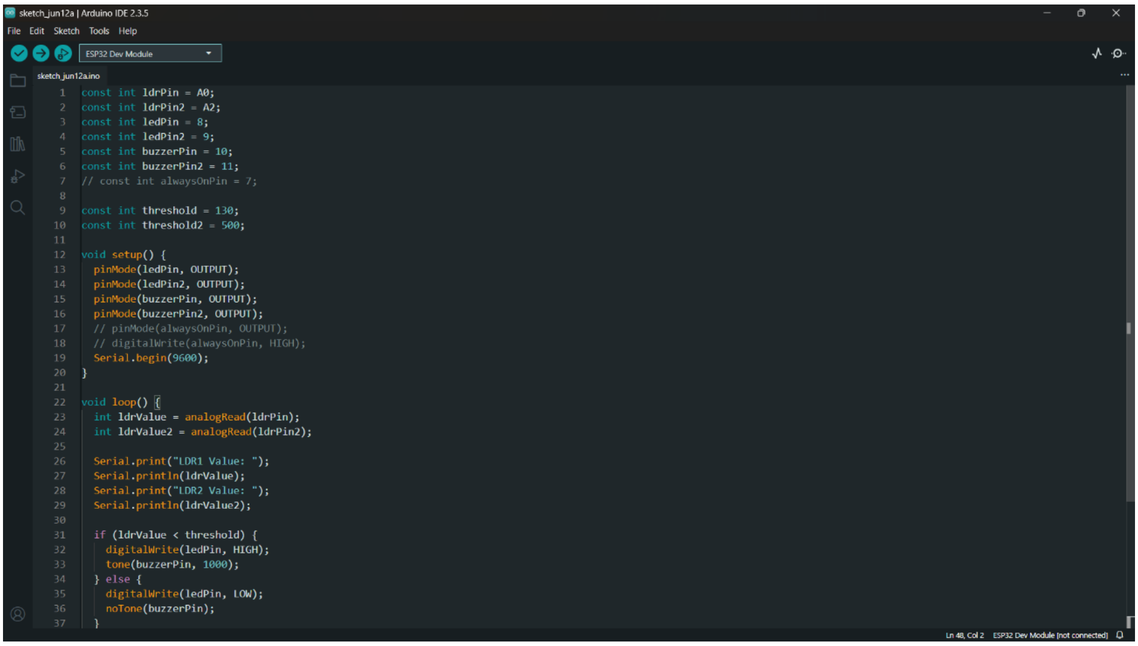

Figure 4.3 Arduino Code Created By ARDUINO IDE

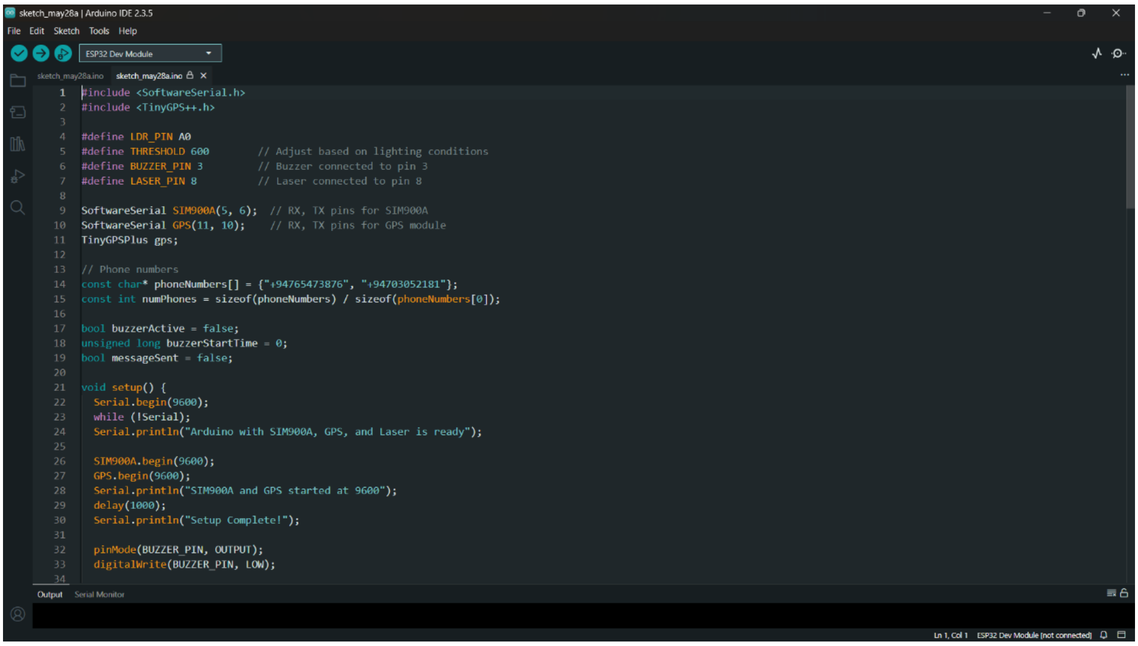

Figure 4.4 Arduino Code Created By ARDUINO IDE

Figure 4.6 Arduino Code Created By ARDUINO IDE

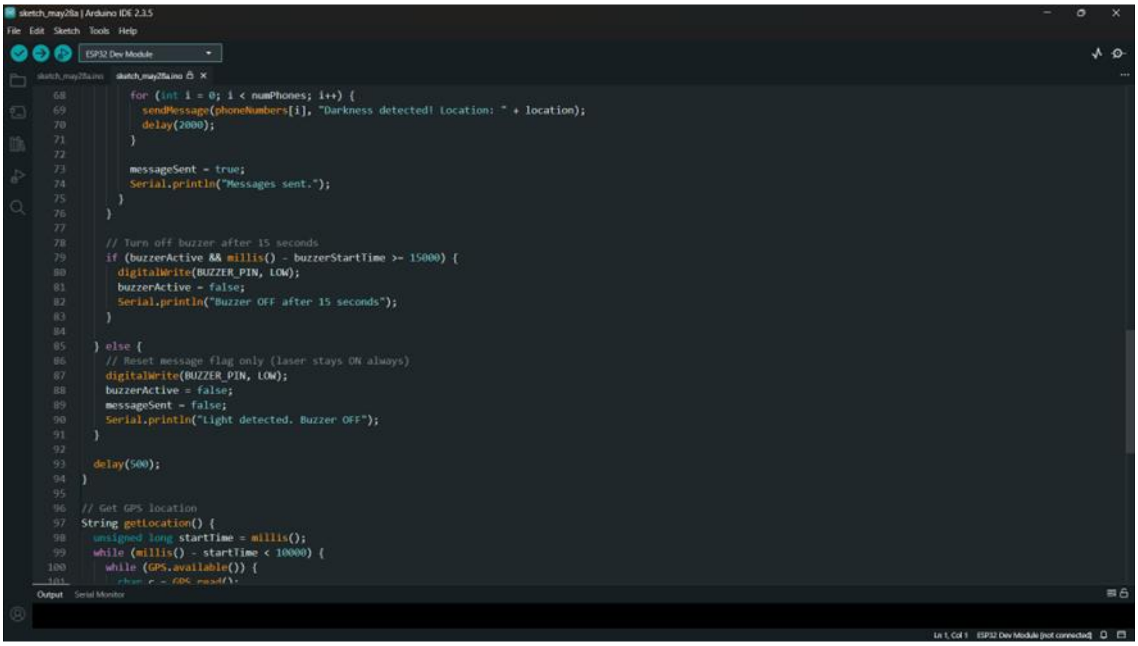

Figure 4.5 Arduino Code Created By ARDUINO IDE

Figure 4.7 Arduino Code Created By ARDUINO IDE