Design Report: Alien Scanner System

1. Introduction

This report details the design and development of a handheld Alien scanner system from the movie series “Alien”, capable of detecting objects within a range of 1m. The device employs an Arduino Nano and Raspberry Pi 3+ for processing and communication, integrating an ultrasonic sensor and servo motor for range detection, a HyperPixel 4.0 screen for visualization, and an auditory feedback system to indicate object distance.

2. System Overview

The system consists of:

- **Ultrasonic Sensor**: HC-SR04 sensor for object detection.
- **Arduino Nano**: Processes ultrasonic sensor data.
- **Raspberry Pi 3+**: Renders visual tracking and processes data.
- **HyperPixel 4.0 Screen**: Displays object tracking information.
- **Buzzer**: Indicates object proximity through variable durations.
- **Housing**: 3D-printed enclosure to secure components.
- **Communication**: Wired I2C interface between the Arduino and Raspberry Pi.

3. Design Considerations

3.1 Sensor Placement and Coverage

The ultrasonic sensor is mounted onto the servo motor which moves within a 90 degree azimuth range to maximize detection coverage.

3.2 Communication Protocol

The Raspberry Pi communicates with the Arduino using an I2C interface. The HyperPixel 4.0 screen has a dedicated I2C channel (/dev/I2C-11).

3.3 Audible Feedback System

The buzzer produces a short-duration beep for close objects and a longer-duration beep for distant objects, synchronized with the visual interface.

3.4 Visual Interface

The interface, designed using Pygame, displays a ranged grid with the detected object's position. A blip effect highlights any movement.

3.5 Housing and Wiring

The device is housed in a 3D-printed case, securing internal components.

4. Future Scalability and Enhancements

4.1 Extended Range Capability

To improve object detection beyond 10 m, higher-frequency ultrasonic sensors or LiDAR could be integrated.

4.2 Power Supply Improvements

A suitable battery-powered version should be explored for portability.

4.3 Security Enhancements

Implementing encrypted I2C communication and handshaking could improve data security between Arduino and Raspberry Pi.

4.4 Advanced PCB Design

A dedicated PCB could streamline sensor connections and power distribution, enhancing manufacturability.

5. Conclusion

This project successfully demonstrates the theoretical development of handheld Alien scanner systems with a visual and audio interface. Future improvements could focus on range extension, security, and battery integration to enhance usability and portability.