OAK LABS

Future engineer's JOURNAL

Team No. 1121
Aneesh, Supratiik, & Krishna

The Team

Aneesh

Aneesh – Mechanical Design, Arduino Coding

- Designed CAD chassis and 3D-printed sensor housings.
- Programmed motor control and servo calibration.
- Integrated mechanical and electronic systems seamlessly.

Supratiik

Supratiik – GitHub Documentation, Raspberry Pi Coding

- Managed GitHub repository and version control.
- Developed obstacle detection and stereo vision algorithms.
- Created replication-ready documentation for future scalability.

Krishna

Krishna – Documentation, Arduino & Raspberry Pi Coding

- Integrated Arduino (sensors, steering) with Raspberry Pi (vision, decision-making).
- Built computer vision pipeline using Python + OpenCV.
- Authored the Engineer’s Journal and technical documentation.

TABLE OF CONTENTS

1. Mobility Management

Chassis Design

- Custom CAD-modeled & 3D-printed chassis
- Optimized weight distribution → low center of gravity & stability
- Structural rigidity validated through iterative load simulations

Propulsion System

- DC motors with L293D H-bridge motor driver
- Transmission ratio optimization tested for minimal wheel slippage
- Enhanced power transfer efficiency across gear ratios

Steering System

- High-torque servo motor with PWM control
- Calibrated geometry → balanced turning radius & response time
- Ensured smooth lane transitions during maneuvers
- Engineering Calculations aph text

Engineering Calculations

- Mechanical + electrical load calculations performed
- Considered torque, angular velocity, and traction coefficients

2.POWER & SENSE MANAGMENT

Power & Sense Management

- Power Architecture
  - Dual-source: Li-ion battery for Arduino, power bank for Raspberry Pi.
  - Energy audit ensured stable voltage and prevented brownouts.
- Perception System
  - Stereo vision with dual webcams for lane detection & sign recognition.
  - Depth estimation improved accuracy in feature extraction.
- Sensor Fusion
  - HC-SR04 ultrasonic sensor for obstacle ranging.
  - Combined with vision data for reliable detection.
- Wiring & Stability
  - Structured wiring plan + Bill of Materials (BOM).
  - Capacitor-based decoupling reduced noise and stabilized signals.

OBSTACLE MANAGEMENT

- **Vision-Based Detection**
- Python + OpenCV pipeline for obstacle segmentation
- NumPy computations enabled real-time matrix operations
- **Decision-Making Algorithm**
- Flowchart-based logic converted sensor data into avoidance maneuvers
- Fusion of vision + ultrasonic inputs for reliable decisions
- **Safety & Reliability**
- Failsafe stop protocol triggered on conflicting sensor signals
- Priority given to collision prevention over lane-following
- **Ultrasonic Integration**
- Arduino trigger–echo time-of-flight algorithm for precise ranging
- Millimeter-scale accuracy achieved during testing
- **Performance Validation**
- Avoidance maneuvers maintained lane alignment
- System proven robust under multi-variable test scenarios

GITHUB UTILIZATION

GitHub Utilization

- Repository Structure
  - /software – Python and Arduino source code
  - /hardware – CAD models, wiring diagrams, 3D-print files
  - /docs – Engineer’s Journal, schematics, testing protocols, performance logs
  - /media – Photos, annotated diagrams, demonstration videos
- Version Control & Collaboration
  - Git used with descriptive commit messages (e.g., fix, feat, tune)
  - Frequent commits by all team members demonstrate distributed collaboration
  - Ensures iterative refinement and traceability of changes
- Documentation & Replication
  - README.md includes setup instructions, architectural explanations, and replication guidelines
  - Supports knowledge transfer for future teams

ENGINEERING FACTOR

Engineering Factor

- **Custom Architecture & Modularity**
  - Integrated off-the-shelf components into a bespoke, scalable system
  - Guided by principles of modularity and expandability
- **Chassis & Mechanical Design**
  - 3D-printed chassis iteratively refined, reducing weight by 20%
  - Maintained structural rigidity while optimizing maneuverability
  - Adjusted mechanical elements to improve transmission efficiency
- **Electrical & Sensor Optimization**
  - Power regulation circuits improved to mitigate instability
  - Sensor suite designed for maximum field-of-view for lane detection and obstacle avoidance
- **Iterative Engineering Cycle**
  - Early prototypes addressed overweight, energy inefficiency, and imbalance
  - Final design achieved lightweight, reliable, and optimized autonomous platform
  - Demonstrates analysis → prototyping → testing → refinement

THANK YOU