# ABSTRACT

The project "**SABER: Strandbeest Autonomous Bot for Efficient Roving**" aimed to design and develop an autonomous roving bot inspired by Strandbeests, focusing on efficient terrain adaptation and navigation. The motivation behind the project was to replicate the adaptability and efficiency of Strandbeests' walking mechanism in a robotic platform.

The project's objectives were to design an autonomous bot that could adapt to **different terrains** efficiently, incorporate **obstacle detection and avoidance capabilities**, and **navigate autonomously**. The scope of the project involved the selection and integration of hardware components such as Arduino boards, motor, motor drivers, and sensors. Additionally, CAD software, specifically **AutoCAD Fusion 360**, was used for designing the Strandbeest linkages.

Through hardware implementation, the project utilized components such as Arduino Uno, NRF transceiver, Bo motor, L298D motor driver, servo motor, and ultrasonic sensor. The software implementation involved programming the Arduino boards using the Arduino IDE and utilizing AutoCAD Fusion 360 for designing the Strandbeest linkages.

The results of the project demonstrated the successful development of an autonomous roving bot with the ability to adapt to different terrains, navigate autonomously, and avoid obstacles. The implications of the project are significant, with potential applications in search and rescue operations, exploration in hazardous environments, and surveillance in inaccessible areas.

While the project achieved its objectives, certain limitations were identified, such as optimizing the walking mechanism for diverse terrains and improving power management for prolonged operation. Future work could focus on integrating advanced sensors for enhanced perception and implementing more sophisticated algorithms for improved navigation and path finding decision-making.

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# Chapter 1

# INTRODUCTION

## 1.1 Introduction

The autonomous roving bot project aims to create a novel and innovative robotic system inspired by the fascinating walking mechanism of **Strandbeests**. Strandbeests, invented by the renowned artist **Theo Jansen**, are kinetic sculptures that can walk independently on various terrains using wind power. By emulating this remarkable walking mechanism, we aim to develop a versatile and adaptable autonomous bot capable of efficiently navigate in different environments.

## 1.2 Objective

The objectives of this project include designing and building a functional autonomous roving bot with a Strandbeest-inspired walking mechanism, addressing the challenges of terrain adaptation, power management, and path planning/navigation. The scope of the project encompasses the integration of hardware components such as Arduino boards, motor drivers and sensors. Additionally, the software development involves programming the Arduino boards, implementing algorithms for obstacle avoidance and path planning, and designing the Strandbeest linkages using CAD software.

## 1.3 Scope of the Work

The future work focus on addressing the limitations and expanding the capabilities of the autonomous roving bot.

Improving the walking mechanism to handle rough terrains and integrating advanced sensors for more precise obstacle detection and mapping could enhance the bot's performance.

Additionally, optimizing power management systems to extend the battery life and implementing advanced algorithms for intelligent decision-making can further enhance its autonomy.

The development of a user-friendly interface for remote control and additional features like object manipulation or communication capabilities can also be explored.

# Chapter 2

# METHODOLOGY

## 2.1 Introduction

The methodology adopted in this project encompasses the selection and integration of hardware components, the use of CAD software for designing the Strandbeest linkage, and the implementation of algorithms for obstacle avoidance

## 2.2 Block Diagram

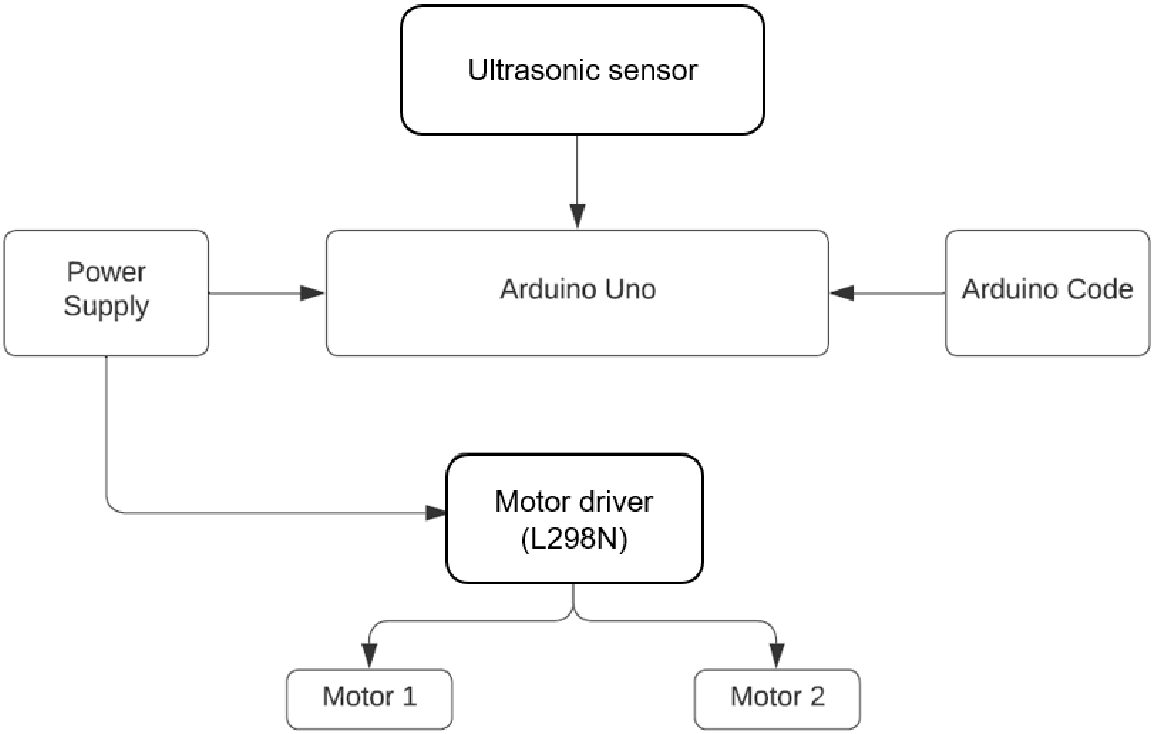



**Fig 2.1**

## 2.3 Circuit Diagram:

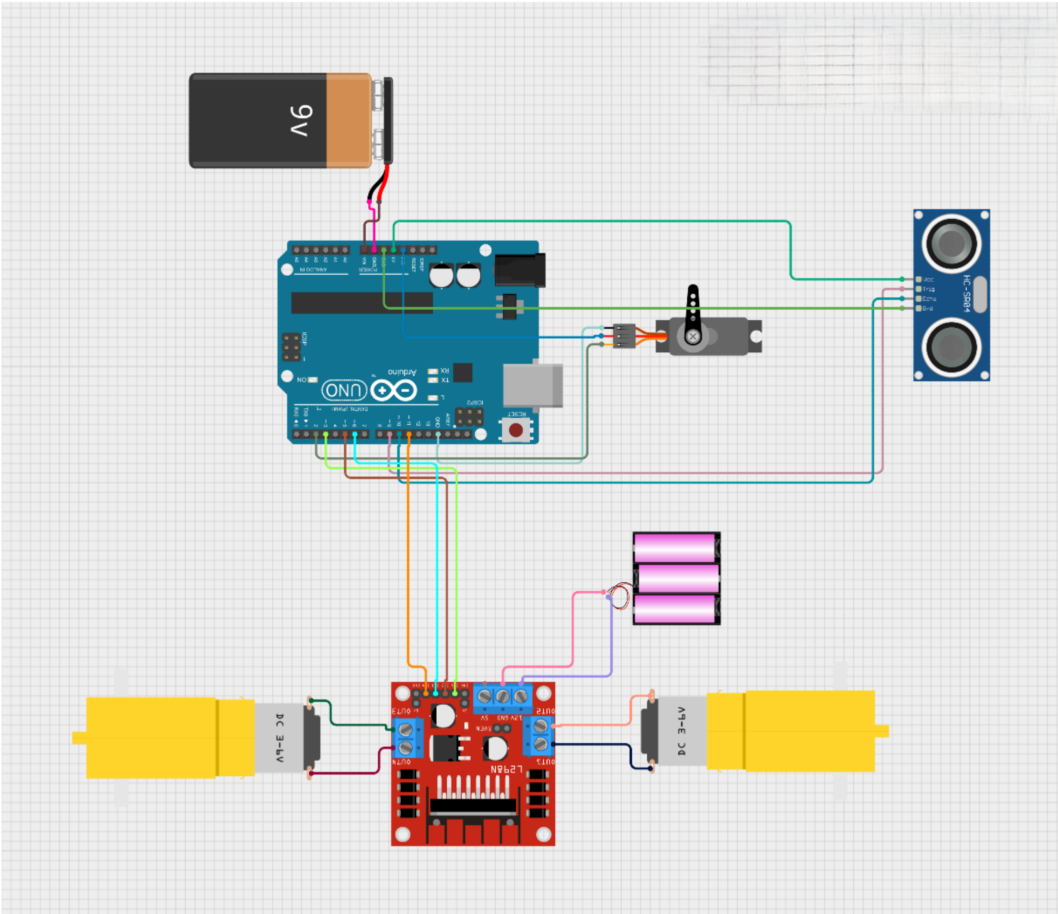



**Fig 2.2**

The project began by assembling the mechanical chassis as outlined in the guide, followed by the integration of electronics and motor control systems. CAD tools were used to modify and optimize the chassis for our specific needs. Algorithms were developed to enable the bot's autonomy, including obstacle avoidance and path planning.

# Chapter 3

# HARDWARE IMPLEMENTATION

| Hardware Component | Description |
|---|---|
| **Arduino Uno** | Microcontroller board used as the main control unit for the roving bot. |
| **Bo Motor** | DC motor used for driving the walking mechanism of Strandbeest. |
| **L298D Motor Driver** | Motor driver module responsible for controlling the movement of DC motors. |
| **Power Supply** | Provides the necessary power to the Arduino board, motor driver, and other components. |
| **3D Printed Strandbeest Linkages** | Custom-designed linkages inspired by Strandbeests, created using a 3D printer. |
| **Servo Motor** | Motor used for rotating the ultrasonic sensor to obtain a wider field of view. |
| **Ultrasonic Sensor** | Sensor used for obstacle detection and avoidance. |

**Table 3.1**

# Chapter 4

# SOFTWARE IMPLEMENTATION

| Software | Description |
|---|---|
| **Arduino IDE** | Integrated Development Environment (IDE) used for programming the Arduino boards. |
| **AutoCAD Fusion 360** | Computer-Aided Design (CAD) software utilized for designing the Strandbeest linkages with precise geometry. |

**Table 3.2**

The **Arduino IDE** is a widely used software tool for programming Arduino boards. It provides a user-friendly interface for writing, compiling, and uploading code to the Arduino Uno board used as the main control unit for the roving bot. The IDE supports the Arduino programming language, which is based on C/C++, making it accessible to both beginners and experienced programmers.

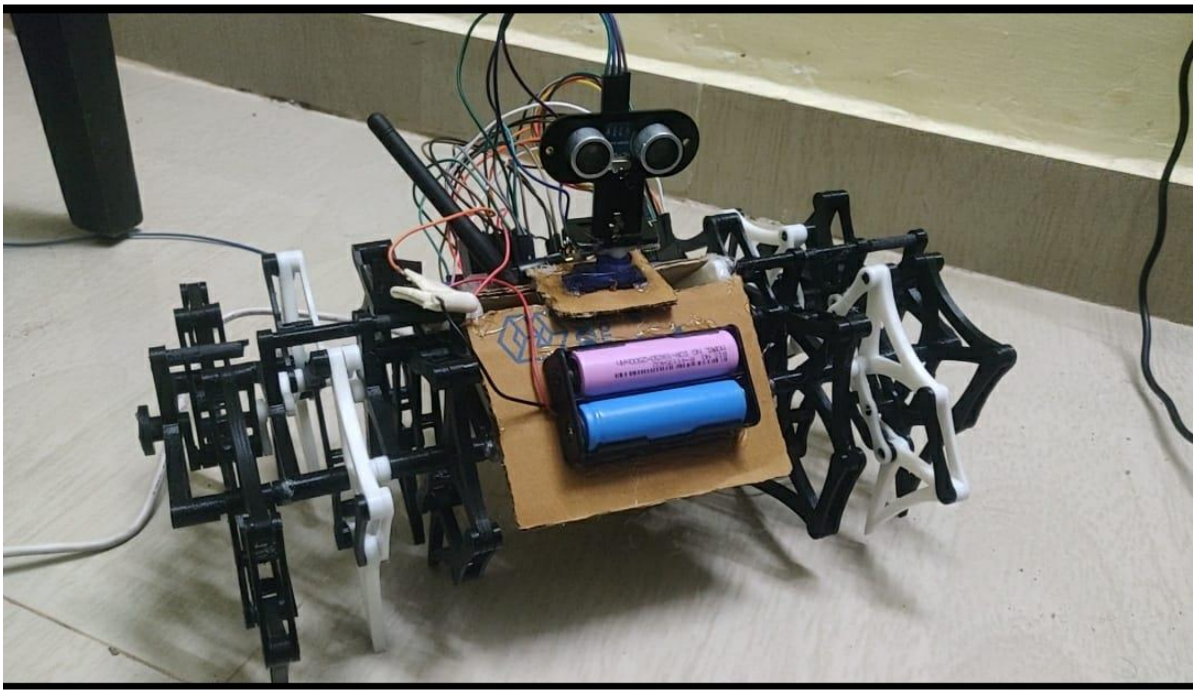
**AutoCAD Fusion 360** is a professional-grade CAD software that offers comprehensive design capabilities. It is used in this project specifically for designing the Strandbeest linkages. Fusion 360 allows for the creation of 3D models with accurate dimensions, intricate geometries, and movement simulations. The software enables the precise design and visualization of the linkages, ensuring compatibility with the overall structure of the roving bot.

# Chapter 5

# RESULTS

- The **SABER** project was successfully implemented in **practical use**.
- Maneuvering was made **more efficient**.
- Maneuvering in **autonomous mode** without user intervention.

Future Scope: We can enhance this current technology by using **Lo-Ra(Long Range) technology** instead of normal nRF module for greater range for transmission, and instead of ultrasonic sensor we can use Lidar sensors for better autonomous navigation and better path navigation protocols.



# Chapter 6

# CONCLUSION

This project **aim**ed to develop an autonomous roving bot inspired by the unique walking mechanism of Strandbeests. The combination of 3D printed Strandbeest linkages, motor control systems, and sensor integration allowed the bot to adapt to different terrains efficiently. The implementation of algorithms for obstacle avoidance, path planning, and mapping further enhanced the autonomy of the bot. Through the selection and integration of hardware components, such as Arduino boards and motor drivers, along with the use of CAD software for designing the linkages, a functional and innovative roving bot was created.

The **Future work** focuses on addressing the limitations and expanding the capabilities of the autonomous roving bot improving the walking mechanism to handle rough terrains and integrating advanced sensors for more precise obstacle detection and mapping could enhance the bot's performance. Additionally, optimizing power management systems to extend the battery life and implementing advanced algorithms for intelligent decision-making can further enhance its autonomy. The development of a user-friendly interface for remote control and additional features like object manipulation or communication capabilities can also be explored.

**Inference** from this project highlights the feasibility of designing and building an autonomous roving bot inspired by Strandbeests. The successful integration of hardware components, the utilization of CAD software for precise design, and the implementation of algorithms for autonomy demonstrate the potential of such a concept. The project showcases the importance of interdisciplinary approaches, combining mechanical engineering, electronics, software development, and robotics, to achieve innovative and practical solutions. The knowledge gained from this project can contribute to advancements in autonomous robotics and inspire further research and development in this field.

# REFERENCES


1. https://github.com/
2. https://www.arduino.cc/
3. https://www.strandbeest.com/
4. https://www.autodesk.in/products
5. Building the strandbeest (nablu.com)

# Appendix A – Datasheets of Components used

## 1. Ultrasonic Sensor

| **Model No.** | **HC-SR04** |
|---|---|
| Working Voltage | 5v |
| Working Current | 15mA |
| Working Frequency | 40Hz |
| Max Range | 4m |
| Min Range | 2cm |
| Measuring Angle | 15 degree |

## 2. Motor Driver

| | |
|---|---|
| Motor controller | L298N, drives 2 DC motors |
| Operating Voltage | 5- 35V |
| Logic voltage | 4.5 – 7 V |
| Max current | 2A per channel |
| Voltage Regulator | 78M05 |
| Module dimensions | 43 x 43 x 28 mm |
| Junction operating temperature | -25 to $130^{\circ}$ Celsius |

### 3. Arduino Uno

| Microcontroller | ATmega328 |
|---|---|
| Clock Speed | 16MHz |
| Operating Voltage | 5V |
| Maximum supply Voltage (not recommended) | 20V |
| Supply Voltage (recommended) | 7-12V |
| Analog Input Pins | 6 |
| Digital Input/Output Pins | 14 |
| DC Current per Input/Output Pin | 40mA |
| DC Current in 3.3V Pin | 50mA |
| SRAM | 2KB |
| EEPROM | 1KB |
| Flash Memory | 32KB of which 0.5KB used by boot loader |

### 4. Servo motor

| Servos | SG90 |
|---|---|
| Torque (kg.cm) | 1.3 (4.8v) 1.5 (6.0v) |
| Length | 23.0 mm (+0.0/-0.8) |
| Width | 12.2 mm (+0.0/-0.2) |
| Height | 32.0 mm (+0.0/-1.0) |
| Bottom of Bracket to top of the servo horn | 15 mm - 12.5 mm |